Proceedings
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Telematics for Vehicle Control :

An overview of the current & planned EU R&D activities

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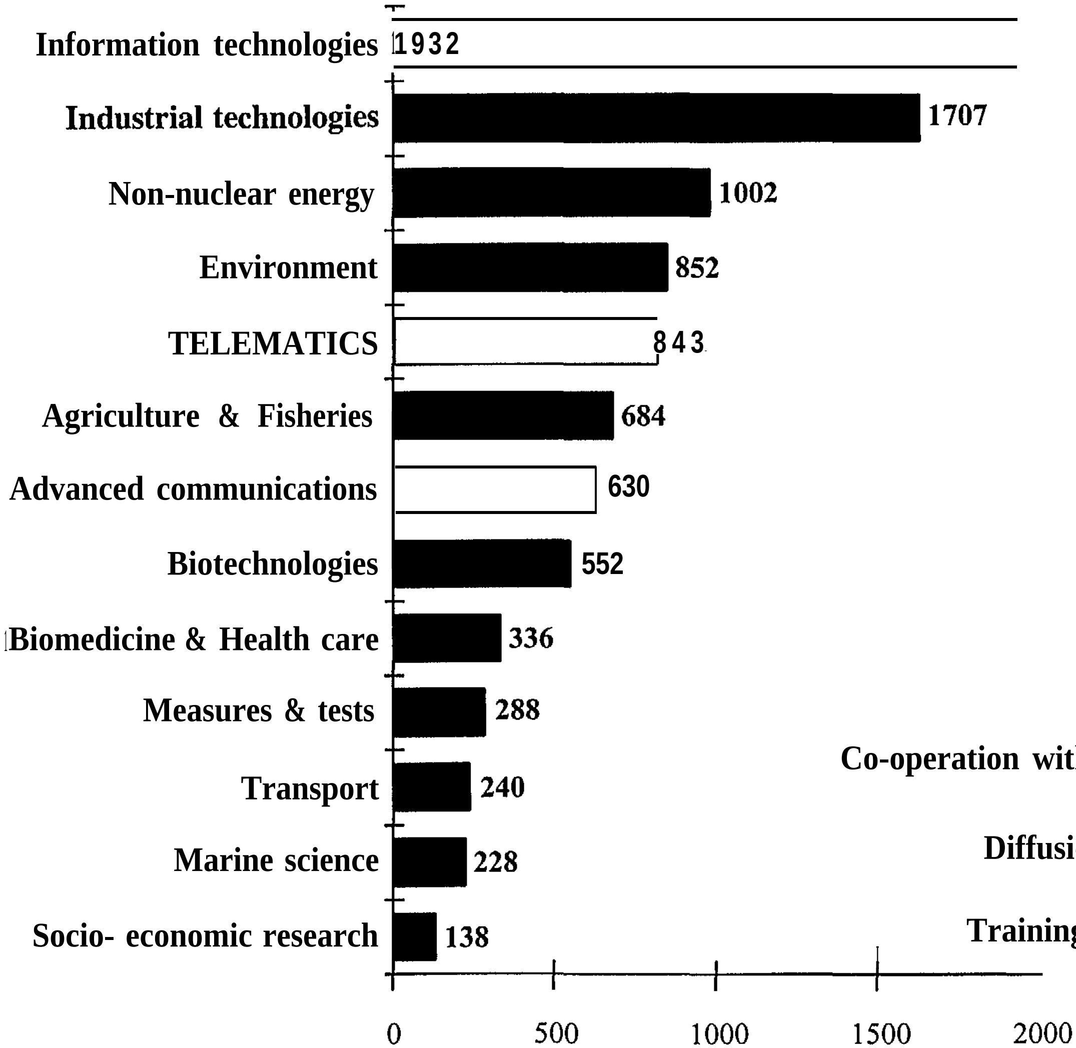
I

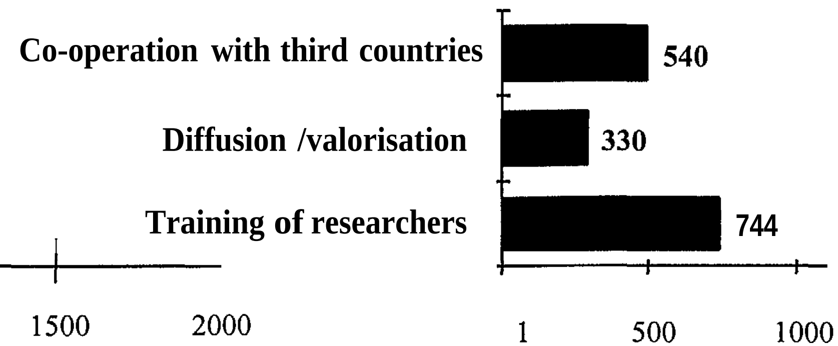
CURRENT EU R&D :
FOURTH FRAMEWORK PROGRAMME
(1994 - 1998)

4th Framework Programme 1994 - 1998

Total budget : 12.3 BECU 1994 - 1998 + top up



1 ECU = US$ 1.1



4FP - TELEMATICS APPLICATION PROGRAMME

- Administration
- Healthcare
- Transport
- Research Networks
- Education / Training
- Libraries

4FP - TELEMATICS APPLICATION PROGRAMME (cont'd)

- Urban / Rural Areas
- Disabled / Elderly
- Environment
- Telematics Engineering, Language and Information Engineering

Telematics for Transport

Project Lines

Advance of state of the art

1	2	3	4	5
Telematics Services for Travellers	Telematics Services for Freight Operations	Telematics Services for Network Management, Operation and Control	Telematics for Fleet Operations	Telematics for Vehicle Control

Integration and Assesment

6 Validation - Integrated Services → Digital Sites

TT Research and support activities

7 Support actions

TELEMATICS FOR VEHICLE CONTROL (ROAD)

Telematics for Vehicle Control

Projects	Main applications
• AC-ASSIST	longitudinal collision warning/avoidance
• CHAUFFEUR	co-operative driving (electronic towbar), IVC/SRC
• SAVE	driver monitoring & warning, emergency handling
• UDC	remote speed recommendations, autonomous vehicle control
• VASCO	DRSC validation

Telematics for Vehicle Control

New projects under negotiation

- RESPONSE - LEGAL and LIABILITY ASPECTS for ADVANCED DRIVER SUPPORT SYSTEMS
- LACOS - LANE CHANGE, LANE/ROAD DEPARTURE
- IN-ARTE - DRIVER SUPPORT for INTERSECTION HANDLING, LANE CHANGING, SPEED SELECTION (RURAL ROADS)

COMMUNITY STRATEGY AND FRAMEWORK FOR THE DEPLOYMENT OF RTT IN EUROPE (MAY '97)

DEPLOYMENT OF RTT
(cont'd)

PRIORITIES

- RDS/TMC
- ELECTRONIC FEE COLLECTION
- DATA EXCHANGE & INFO MANAGEMENT
- HMI
- SYSTEM ARCHITECTURE

DEPLOYMENT OF RTT
(cont'd)

OTHER APPLICATIONS

- PRE, ON-TRIP INFORMATION & GUIDANCE
- INTER-URBAN TRAFFIC MANAGEMENT
- URBAN TRANSPORT TELEMATIC SERVICES
- COLLECTIVE TRANSPORT
- ADVANCED VEHICLE SAFETY/CONTROL SYSTEMS
- CVO

DEPLOYMENT OF RTT
(cont'd)

ADVANCED VEHICLE SAFETY/CONTROL SYSTEMS TECHNICAL HARMONISATION:

- **DRIVER EMERGENCY ASSISTANCE**
- **ANTI-THEFT**
- **ON-BOARD DIAGNOSTIC/ASSISTANCE**

LEGISLATION

Legal and liability aspects related to testing, certification, consumer, provider and manufacturer responsibility.

II

A DISCUSSION OF THE FIFTH R&D (1998 - 2002) FRAMEWORK PROGRAMME PROPOSAL

STRUCTURE - PROPOSAL 1

THE LIVING WORLD
(28%)

INFROMATION SOCIETY
(28%)

KEY ACTION

KEY ACTION

COMPETITIVE & SUSTAINABLE GROWTH (28%)

KEY ACTION

KEY ACTION

THE INTERNATIONAL ROLE

SMES

HUMAN POTENTIAL

STRUCTURE - PROOSAL 2

INFO SOCIETY

KEY ACTION 1

SERVICES FOR CITIZENS

-

- TRANSPORT

GROWTH

SUSTAINABLE MOBILITY & INTERMODALITY

MARINE TECHNOLOGY

AERONAUTICS

CITY OF TOMORROW

COMPETITIVE AND SUSTAINABLE GROWTH

KA 1 - SUSTAINABLE MOBILITY & INTERMODALITY

- Modal and Intermodal, including GNSS
- Infrastructures & Interfaces
- Socio - Economic Scenarios

COMPETITIVE AND SUSTAINABLE GROWTH **(cont'd)**

KA 6 - CITY OF TOMORROW

- Integrated Supply, Use, Management of Essential Resources
- Preservation of Cultured Heritage
- Economic, Clean, Safe, Intelligent Vehicles

INFORMATION SOCIETY

KA 1- SERVICES FOR CITIZENS

TRANSPORT

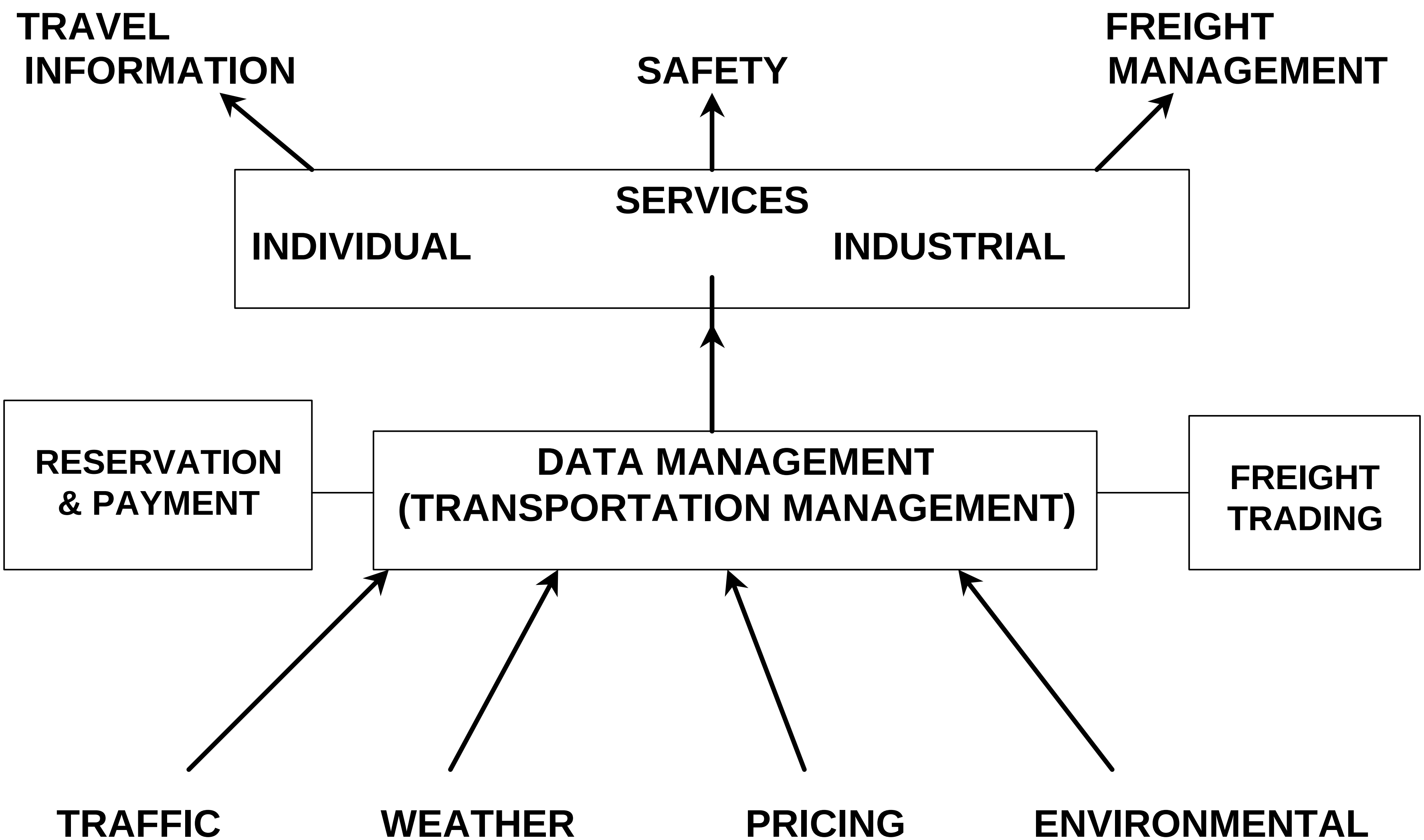
- Intelligent Transport Management
- Associated Tele-Services

WORK PROPOSED - 2

2 THEMES

- Information-based Transport Management Infrastructure and Mobiles
- Multimedia Info-Mobility and Associated Services

WORK PROPOSED - 3



WORK PROPOSED - 4

ON BOARD SYSTEMS

ROAD	AIR	WATER	RAIL
DRIVER ASSISTANCE	"AUTONOMOUS" AIRCRAFT	"INTELLIGENT" SHIPS	AUTOMATIC CARRIAGES AND TRAINS

WORK PROPOSED - 5

THEME 2

- Personal Mobility
- Virtual Mobility
- Security
- Usability
- Freight / Fleet Operations
- Travel / Leisure / Tourism
- Weather

ADVANCED DRIVER ASSISTANCE SYSTEMS

Objectives

- Improve Safety
- Increase Efficiency

IS - KAI - SYSTEMS AND SERVICES FOR THE CITIZEN (cont'd)

ADVANCED DRIVER ASSISTANCE SYSTEMS

Technologies and Applications

- Vision Enhancement
- Obstacle Detection, Crash-Avoidance
- V2V Communications
- Cruising, Lane Keeping Support
- Driver Impairment
- Electonic Coupling of Vehicles

Vehicle Automation in Europe

Vehicle Automation in Europe - Past and Present

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1 st International AHS Conference, San Diego CA, August 11 and 12, 1997

Attachment # 11-2-B

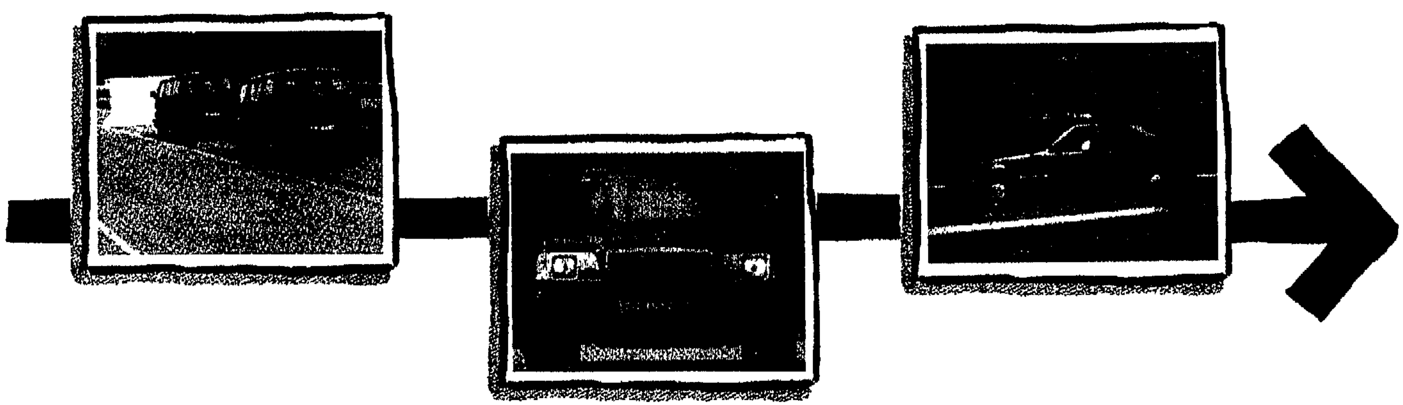
Vehicle Automation - Definition

Vehicle automation is not limited to autonomously driving vehicles. Driver assistance under normal and potentially dangerous conditions or in emergency situations is also considered here.

Vehicle Automation in Europe in the Past (1986 - 1994)

PROMETHEUS: PROgraMme for a European Traffic with Highest Efficiency and Unprecedented Safety

- Cooperative driving systems
- Autonomous intelligent cruise control
- Collision avoidance systems



Vehicle Automation Projects today

AC ASSIST

Driver assistance I intervention in critical situations

<u>Jaeuar Cars</u>, CRF, Rover, Renault, Volvo, various suppliers and institutes

UDC Urban Drive Control

Traffic flow harmonisation on urban roads

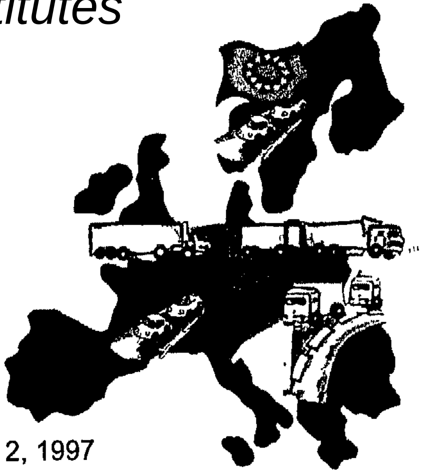
<u>TUV Rheinlanci</u>, CRF, Jaguar Cars, PSA, Renault, various suppliers and institutes

te - CHAUFFEUR

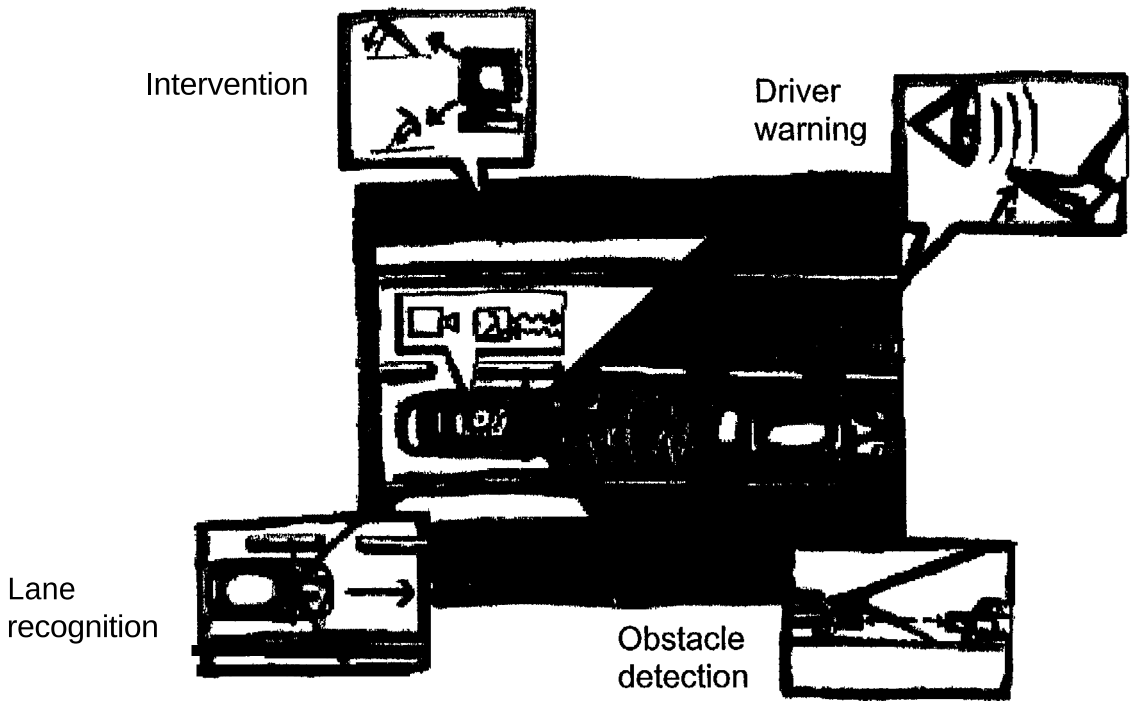
CHAUFFEUR

Electronic coupling of trucks

<u>Daimler-Benz</u>, CRF, IVECO, various suppliers and institutes



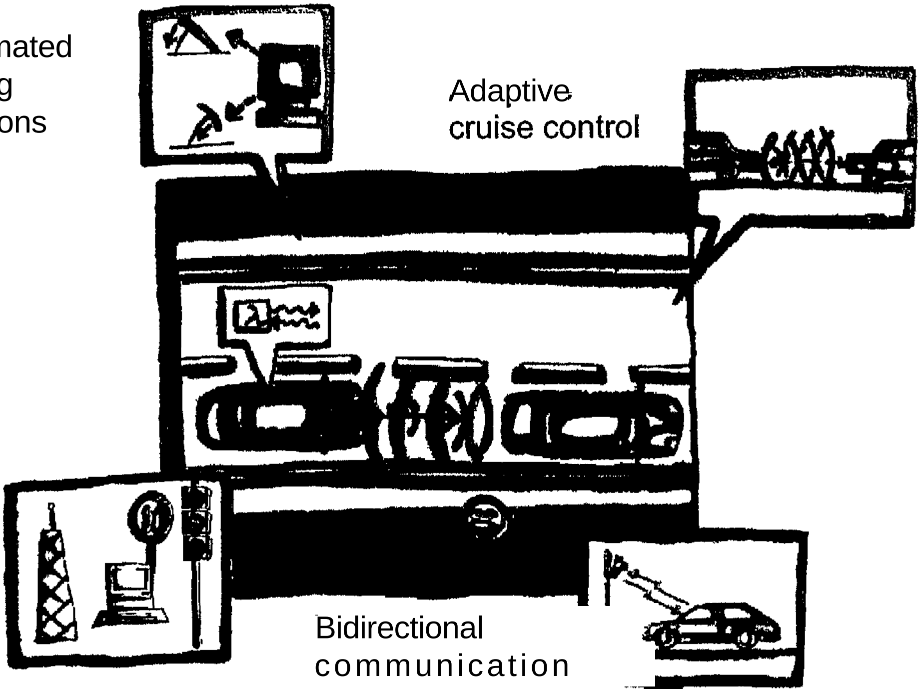
AC Assist - Overview



Autonomous system capable of:

- anti collision functions in longitudinal direction
- providing driver assistance (warning, intervention)

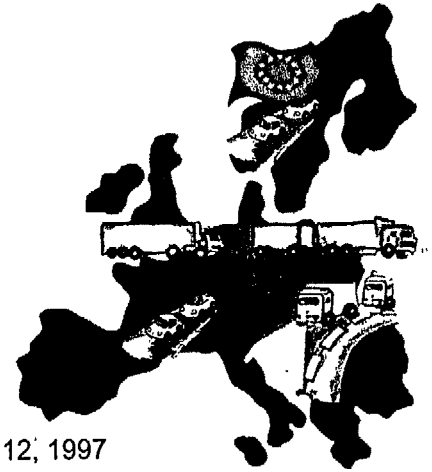
Urban Drive Control - Overview



- Harmonisation of traffic flow
- Throughput optimisation

Safety and comfort

- Travel with safe distance
- Assistance in traffic jams



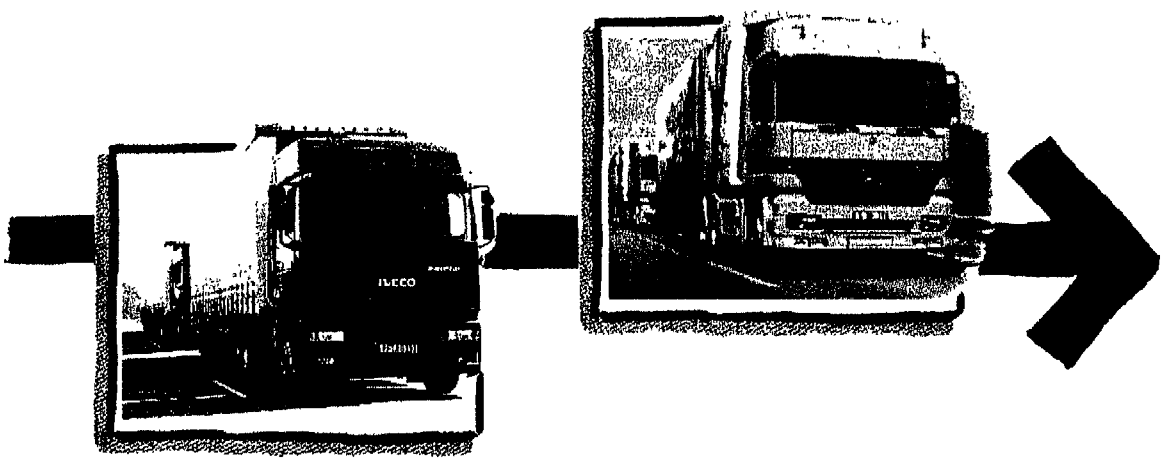
CHAUFFEUR

CHAUFFEUR - Motivation

- Doubling of transport demand in the EU between now and 2010
- 70% of goods transport on the road

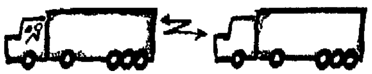
Beside considerable environmental impact this will lead to

- drastically reduced traffic flow
- increase in travel time
- dramatically rising costs for transportation



TE CHAUFFEUR

CHAUFFEUR WI The applications



Tow-Bar

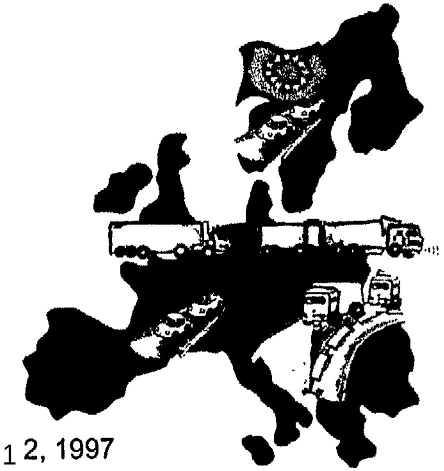
Two trucks are coupled electronically. The leading one is driven conventionally, the second vehicle follows automatically.

Platooning

More than two trucks are coupled electronically.
As before, the leading one is driven conventionally,
the following ones may be driverless.

Automated platooning / automated driving

Autonomously driving truck platoon



Vehicle Automation in Europe

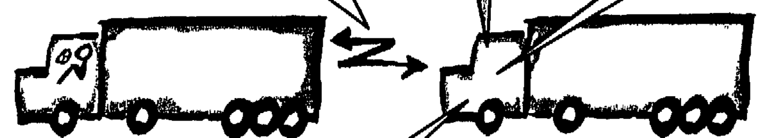
CHAUFFEUR - Who does what?

Tow-Bar system concept
Benz Consult, Bosch, Centro Ricerche Fiat,
Daimler-Benz, ELTRAC, IVECO,
TÜV Rheinland, Wabco, ZF Schwabisch Gnund,
sponsoring partners

Video sensing system
Bosch and Daimler-Benz
in co-operation with
Centro Ricerche Fiat

Vehicle controller
Daimler-Benz and **ELTRAC**
in co-operation with Bosch,
Centro Ricerche Fiat, IVECO,
and TUV Rheinland

Communication system
CRL in co-operation with
Daimler-Benz and ELTRAC



Electronically controlled drive train
Daimler-Benz and IVECO
in co-operation with Bosch, ELTRAC,
and WABOO

Electronic braking system
WABCO in co-operation with
Daimler-Benz ELTRAC, and
IVECO

[illegible]

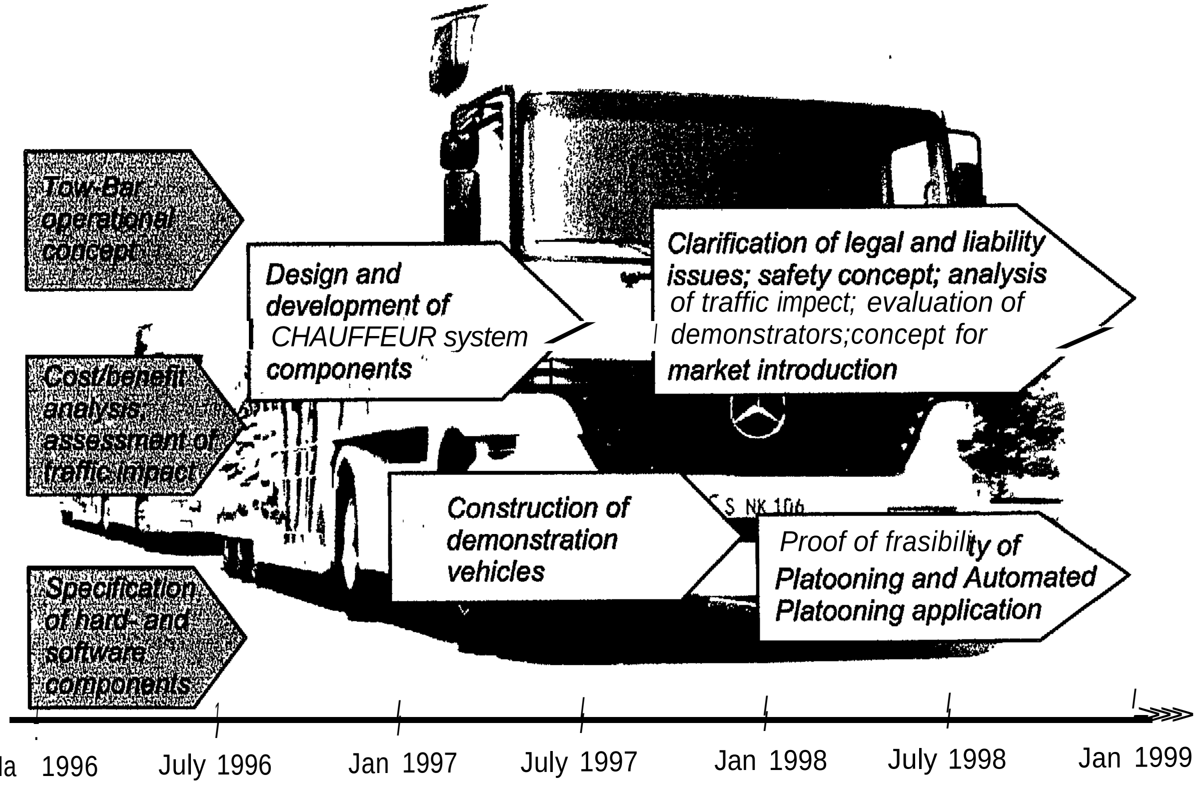
Tow-Bar evaluatiòno
Benz Consult, Bosch, CSST,
Centro Ricerche Fiat, Daimler-Benz, ELTRAC,
IVECO, Punder Volhard, Weber & Axster,
TUV Rheinland, Wabco, ZF Schwabisch Gmund,
sponsoring partners

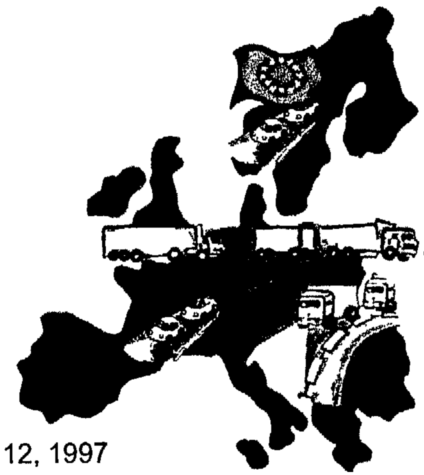
Feasibility of Platooning
and Automated Platooning
Bosch, Daimler-Benz,
IMIZAR Automazione

Vehicle Automation in Europe

CHAUFFEUR

CHAUFFEUR - Timeframe





PREDIT
1996•2000

FRENCH
PRESENTATION
at

First International Workshop on
Automated Highway System

San Diego August 11-12

THE PREDIT PROGRAM

Program management

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1. Program objectives 1996 - 2000

improve public transport level of service

Development of new PT transportation systems & vehicles (less pollution, less noise, less energy consumption)

Globally improve vehicles and networks safety with emphasis on road transportation

Increase industry competitiveness

Promote large european network construction in respect of efficiency and environment

2. Operational Principles

Fit users' need

Concept and market validation with live demos

Public research involvment

Insure coordination between national and research

3. Program organization

An orientation committee with industrials, operators, research centers and administrations

An executive decisional bureau

A permanent secretary including financing bodies

For each subject, constitution of an executive management board in charge of validating the program

Emphasis on small industry involvement.

4. Thematic orientations

1- Strategic research

2- Basic scientific research

2. 1. energy, environment
2.2. safety, ergonomy, comfort
2.3. conception, production

3- Sciences & Technology

3.1. components & sub-systems
3.2. clean & safe vehicles
3.3. rail equipment
3.4. urban transport vehicles

4- New transportation systems

4.1. urban management
4.2. ITS / AHS
4.3. freight
4.4. rail control/command
4.5. new users services

5. Financing Previsions

Program Domain	Budget (MF)	Public	
		Total	
1. Strategic Research	200	150	
2. Sciences & Technology	1 300	650	

3. Technological Objects	3800	1145
4 Transport Systems	2000	685
5. Program Management	20	20
Total	7320	2650

6. French effort on long term research

Link with European projects
Link with short term industrial objectives

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ENPC ***(Robert Eymard eymarc@enpc. fr)***

LCPC ***(Pierre-Yves Texier***
Pierre- Yves. Texier@lcpc. fr)

ENSMP ***(Claude Laurgeau***
laurgeau@caor.ensmp.fr)

IN **RIA** ***(Michel Parent Michel.Parent@inria.fr)***

AEROSPATIALE ***(Michel Charron***
Michel. (Charron@espace.aerospatiale.fr)

3 main fonctions

Same vehicle door-to-door

High efficiency and high safety

Automatic driving on some portion of the trip

Vehicle level intelligence

Lateral and longitudinal control

System level intelligence

Entrylexit control

Safety enforcement

Six plausible scenarios identified

PANEL OF TRANSPORTATION OPERATORS (DOTS)

operational/service issues

Contribution of DDOT:

AUTOMATED HIGHWAY SYSTEMS (AHS)

IN THE NETIIERLANDS

Mr Carol van Raalten, MsC (DDOT)

tel: ++ 31.70.3518081 fax: ++ 31.70.3519369

e-maol: C.W.A.O. VARAALTEN P HDW.RWS.MINVENW.NL

Attachment #11-2-D

08.11.97

Inventory:

General characteristics of the Netherlands (the NL).

The NL and the European Union (EU).

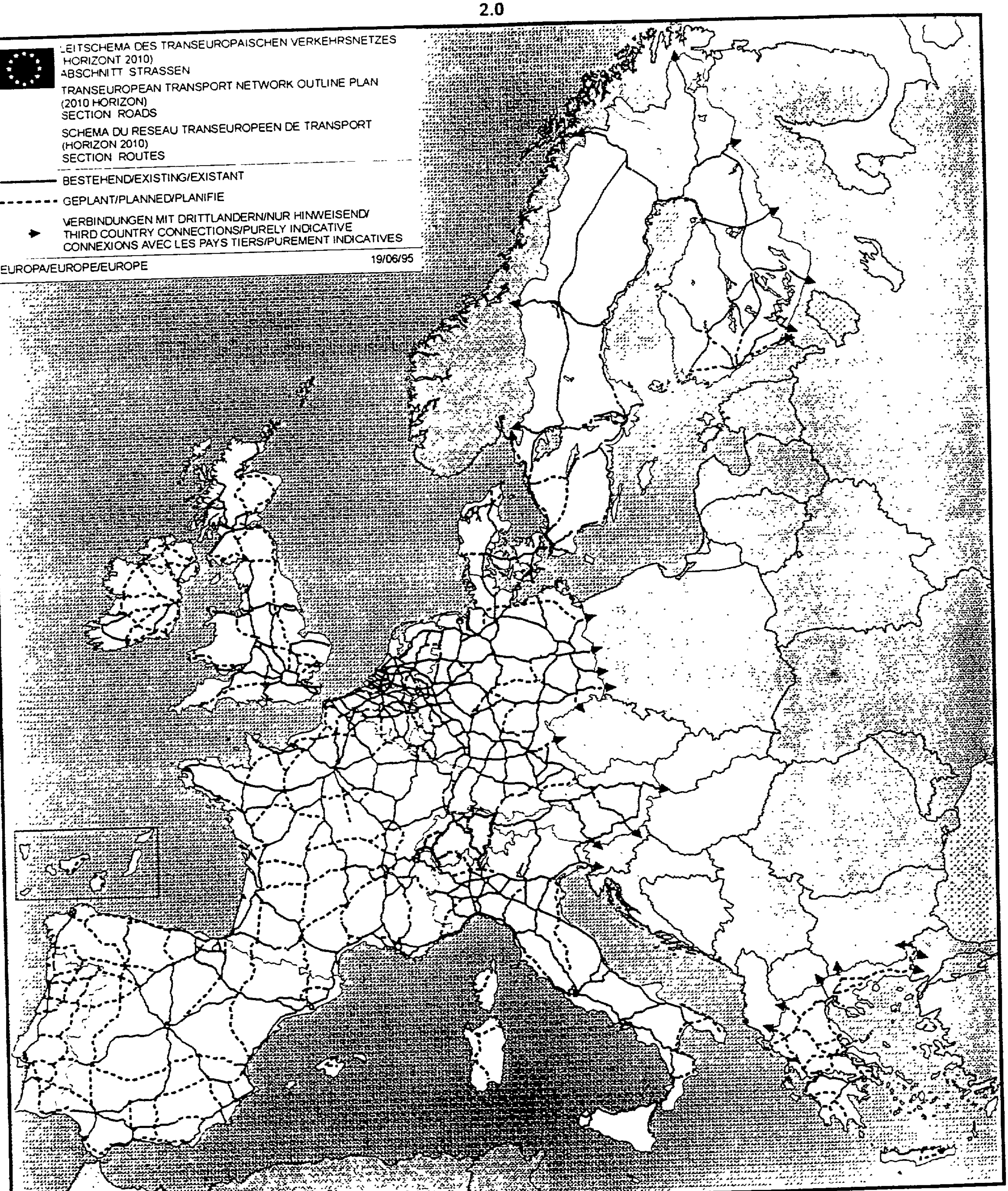
Transport and traffic characteristics of the NL.

Transport policy of the NL.

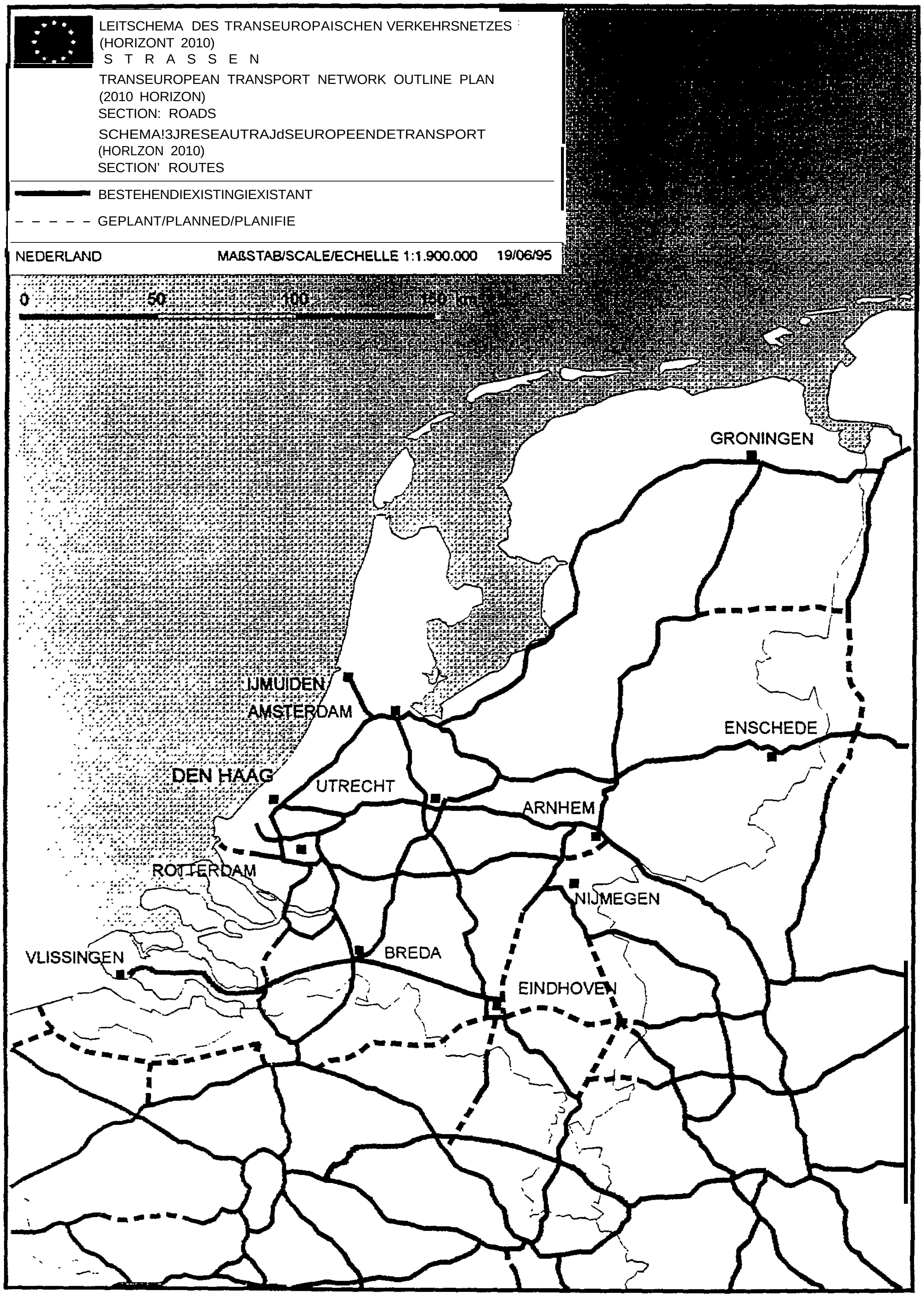
AHS in the NL.

Operational/service issues?

* to be dealt by mr Job Klijnhout of DDOT


LEITSCHEMA DES TRANSEUROPAISCHEN VERKEHRSNETZES
(HORIZONT 2010)
ABSCHNITT STRASSEN
TRANSEUROPEAN TRANSPORT NETWORK OUTLINE PLAN
(2010 HORIZON)
SECTION ROADS
SCHEMA DU RESEAU TRANSEUROPEEN DE TRANSPORT
(HORIZON 2010)
SECTION ROUTES
BESTEHEND/EXISTING/EXISTANT
GEPLANT/PLANNED/PLANIFIE
VERBINDUNGEN MIT DRITTLANDERN/NUR HINWEISEND/
THIRD COUNTRY CONNECTIONS/PURELY INDICATIVE
CONNEXIONS AVEC LES PAYS TIERS/PUREMENT INDICATIVES
19/06/95
EUROPA/EUROPE/EUROPE

2.9


LEITSCHEMA DES TRANSEUROPAISCHEN VERKEHRSNETZES
(HORIZONT 2010)
S T R A S S E N
TRANSEUROPEAN TRANSPORT NETWORK OUTLINE PLAN
(2010 HORIZON)
SECTION: ROADS
SCHEMA!3JRESEAUTRAJdSEUROPEENDETRANSPORT
(HORLZON 2010)
SECTION' ROUTES
BESTEHENDIEXISTINGIEXISTANT
GEPLANT/PLANNED/PLANIFIE
NEDERLAND
MAßSTAB/SCALE/ECHELLE 1:1.900.000
19/06/95
0
50
100
150 km
GRONINGEN
IJMUIDEN
AMSTERDAM
ENSCHEDE
DEN HAAG
UTRECHT
ARNHEM
ROTTERDAM
NIJMEGEN
VLISSINGEN
BREDA
EINDHOVEN

General characteristics of the NL:

Population: 15 mln.
Surface: 40,000 sqkm.
Density: 400 inh/sqkm.

GNP: 300 bln US$/a.
GNP/capita: 20,000 US$.
Transport: 7-8% of GNP.
T' workers: 350,000.
Industry: No major national car industry.

International transport policy:

- The NL intends to be one of the major gateways to Europe.
- The NL is eager to be in the front of all developments in the transport area.
- DDOT is the only European member of NAHS.

The NL and the EU:

The NL is one of the founding members of the EU.

The EU started the harmoniiation of the national transport-policies.

Examples of EU-products in this regard:

- DRIVE-programme (the NL has been one of the founders).
- The TERN (= Trans European Road Network): approximately the combination of all national highway systems of the EU.

Due to subsidiarity, the national administrations keep administering their own national highway system.

The NL and the EU/continuation:

As a consequence of economic growth, (car)mobility increases annually with some percentages in the EU.

The territory of the EU (and as a consequence the TERN) to be split in roughly 2 different economic parts:

- The ‘Banana’ (the territory inside the chain London-Paris-Lyon-Rome-Munich-Hamburg-Manchester-London);
- The ‘Peripheral part’.

Nota Bene: NL is part of the ‘Banana’.

The NL and the EU/continuation:

Simplified characteristics of the. ‘Banana’:

- Metropolitan/conurban area.
- Highway network systems (TERN) have been nearly comple- ted
- Major answer to growth of mobility: Making a better use of existing highway systems (TERN).

Simplified characteristics of the ‘Peripheral part’ :

- Rural area.

  Highway network systems (TERN) haven’t been completed.
- Major answer to growth of mobility: Extension of the existing highway systems (TERN).

<u>The NL and the EU/continuation:</u>

Cars:
In favour of the European car industry, the European Commission (EC) contributes - via a technological push - in the development to sophisticated vehicles (smart cars).

TERN:
To make a better use of existing highway systems, the EC stimulates national initiatives to develop sophisticated cross-border infrastructure (ITS) .

Smart cars' and ITS in the EU:
The development of smart cars influences the development of ITS mutually.

Transport and traffic characteristics of the NL:

Mainports:
- Port of Rotterdam (nr 1 in the World).
- Schiphol airport (nr 4 in Europe).

DDOT:
- Responsible for the national transport policy.
- Administers the national highway system (length 2000 km; major part is part of TERN).

Safety on the national highway system:
1 fata1/3.5 mln kms (lowest rate in Europe) .

Public transport:
Relative dense network.

Transport policy of the NL:

Four policy documents (on the same level as NEX/ISTEA): Transport scheme # 1, Transport scheme # 2, ‘Meer benutten, minder files’ en ‘Samen werken aan bereikbaarheid’:

- Flexible and reliable infrastructure (national highway system).
- A (further) reduction of negative environmental impact.
- A (further) improvement of safety.

Conditions:

Making a better use of existing infrastructure, no major extensions.

Each development has an European/Global dimension.

All options are open.

How to reach these (political) goals?:

Implementing transport policy.

Making a better use of infrastructure by ITS.

Introducing ITS (including AHS) in an evolutionary way.

Introducing ITS/AHS:

Smart cars (AICC).

Traffic management (ATMS/speed control).

Smart infrastructure (AHS).

AHS in the NL:

Short term:

- Intelligent cruise control (AICC).
- Intelligent speed adaptor.

Long term:

- Individual transport of persons.
- Collective transport of persons.
- Transport of goods (Combi-road).

Who is in charge?:

- DDOT.
- Technical and scientific institutes.
- Industry (next stage).

Nota bene: it is the interest of DDOT to improve the transport function of the NL (= gateway to Europe), not to support Industry.

Conversion table USA-Europe:

	USA	Europe
*Umbrella	ITS	ITS
*Control	ATMS	MCSS/MTM
*Information	ATIS	TIC/MT1
*Smart cars + smart infrastructure	AHS	AVG
*Stepping stones to smart cars + smart infrastructure	pre-AHS	AICC Off the road (lane keeping) Intelligent speed adaptor

Conversion table USA-Europe/continuation:

ATMS	=	Advanced Traffic Management System.
MCSS	=	Motorway Control and Signaling System.
MTM	=	Motorway and Tunnel Management.
ATIS	=	Advanced Traveller Information System
TIC	=	[1] ~~Transport~~ Information Centre.
MT1	=	Multimodal Traveller Information system.
AHS	=	Automated Highway System.
AVG	=	Automated Vehicle Guidance.
AICC	=	[2] ~~Automated~~ Intelligent Cruise Control.

1 TRAVELLER

2 AUTONOMOUS

European Projects

From a Dutch DOT perspective

by Job J.Klijnhout

1. **Position of DDOT**
   Policy
   International

2. **Focus so far**
   Study results

3. **Evolution**

DutchDOT

Attachment # 11-2-E

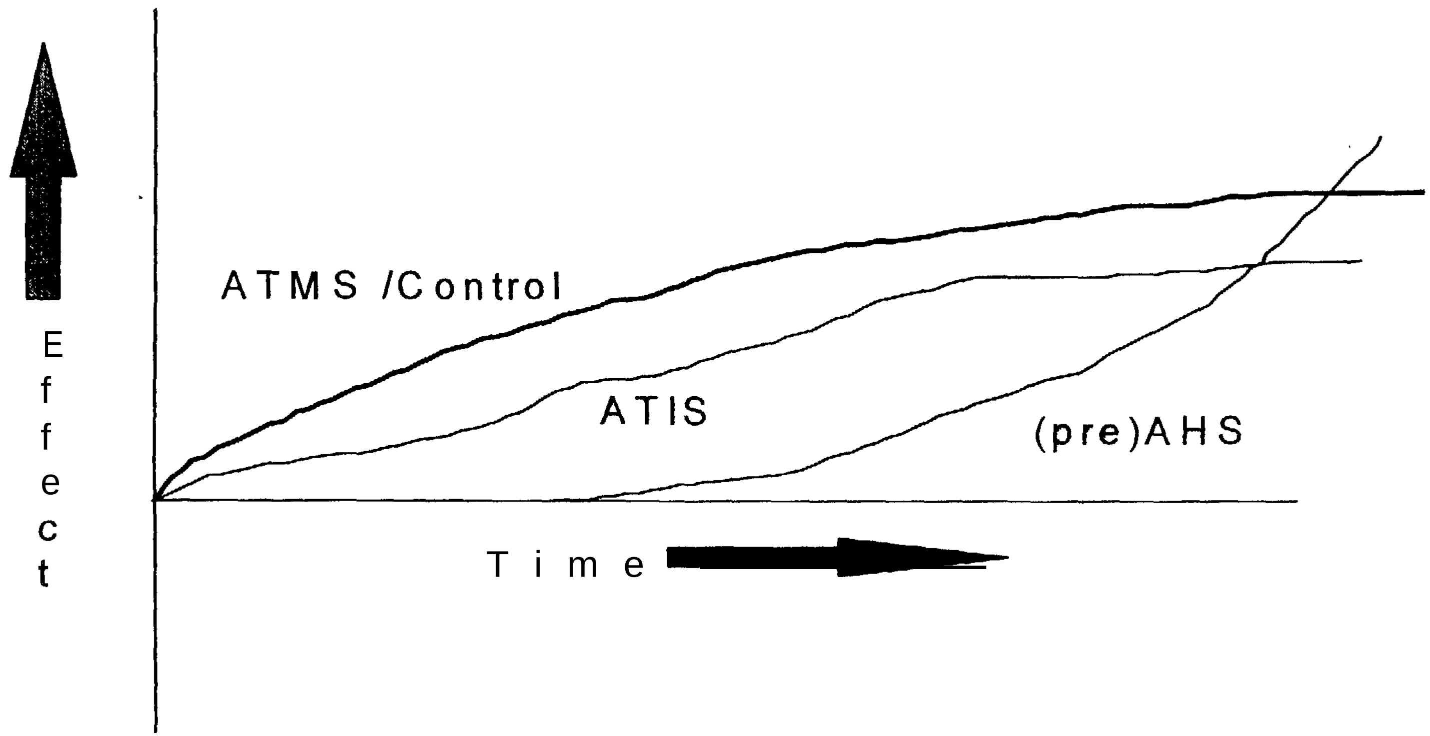
1. Position of DDOT Policy

Effects in year 2010	Traffic Control ATMS	Traveller Inform ation ATIS	HOV CVO lanes .	P re AHS: AICC
Primary Network (Freeways)	78	79	101	71
Secondary Network	97	79	99	97

Indexed comparision of the effect of ITS policy options on vehicle-loss hours where no ITS actions = 100

DutchDOT

1. Position of DDOT Policy



DutchDOT

1. Position of DDOT
Policy

ATMS

Fully automated Freeway and Tunnel Management System working

- it is accepted by the public, drivers obey the signs.
- it is reliable, out of every 10.00 detectors not more than one is not in operation.
- it reduces accidents by some 40%.

- Queuedetection and protection against rear end collisions of vehicles running into queues.
- Lane reservations for road works.
- Speed limits.
- Fog, strong winds and black ice warning.
- Maintenance planning support.
- Smoothing/calming.
- Rerouting,
- Rampmetering
- Truck and/or bus lanes, the Dutch alternative to HOV lanes
- video travel time measurements and automated speed enforcement

600 -700 kilometers interstate type covered

DutchDOT

1. Position of DDOT
Policy

Traffic Information
Cooperation between Dutch AA, Dutch DOT', Broadcasting Companies and the National Police Force.
- Radiobroadcast nationwide, with time intervals ranging from 15 minutes to 1 hour.
- Radiobroadcast by local stations.
- Teletext pages, free text TV broadcast on sidebands of the regular TV
    actual and forecasts,
    national and European
- Dial up in telephone service.

Every 5-8 kilometers of freeway monitored automatically
    speed flow

Dedicated lanes program
HOV no success, bus/trucklanes very successful

1. Position of DDOT
Policy

DDOT: Policy and technology development hand In hand.

Open to all forms of "AHS" not just one final version.

1. Position of DDOT
Policy
International

DDOT in Prometheus Program
Drive and follow-up programs
NAHSC

DutchDOT

2. FOCUS SO far
Study results

Container transport

Automated container movement at ECT terminal in Rotterdam operationai

Reliable, sturdy, look for newer versions

COMBIROAD driverless truck with trailers or train flat bed cars

Tests on testtrack for connection harbor - hub

Automated people mower in Business District linking with Metro (train/bus/P+R)

Scheduled for Rotterdam

Intelligent Speed Adaptation

First tests in GERDIEN project of Drive Program

Jointly with Swedish National Road Administration

Note Infrastructure support by MTM

AICC (plus ISA) and Lane keeping

Behavior studies essential

DutchDOT

2. Focus so far
Study results

Effect AICC

- warning only useless
- without automated emergency brake delayed reaction.
- No need to keep foot on pedal
- Gap of 1.5 seconds OK for <20% penetration

Attitude

- Differences Europe - USA:
  - Distances traveled, experience with cruise control and automated gear box
    - USA special: confort run off the road
  - Expectations about DOT involvement
- Common
  - Very low awareness level
  - Little trust in futly automated highways esp. with females
  - Other more simple ITS services more attractive

DutchDOT

3. Evolution

Targeted niche solutions now

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DutchDOT

AUTOMATED PUBLIC VEHICLES : A FIRST STEP TOWARDS THE AUTOMATED HIGHWAY

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Abstract : we develop a new mode of urban transportation based on two concepts : the concept of car sharing so that the total number of cars in a densely populated area is decreased and made less polluting, and the concept of the automated highway so that these public cars can be made available at any time in a large number of stations placed along a network of dedicated and automated roads. Such a transportation system could offer an alternative to the private automobile but also to public transport systems in places or at times when mass transit is not efficient. In particular, we think that these automated public vehicles could use the existing lanes which are now dedicated to public transport such as the bus lanes or the tram tracks. If we extend the concept of car sharing with the concept of car pooling, this new transportation system could even one day replace some of the mass transit systems with a much better level of service.

INTRODUCTION

Everywhere, the private automobile is now perceived as the most desirable means of transportation for short to medium length trips (say from 500m to 300km!). It is reasonably inexpensive, it is rather safe, it boosts the ego, it offers a private place for many purposes, it can be used to carry or store large objects (or animals), etc. But mostly, a car is synonymous with freedom and this is what makes it so desirable.

However, the automobile alone is not efficient enough to move everyone as they wish. As soon as the density of movements becomes too large, congestion sets in and travel times increase dramatically. The solution of this problem of freedom to move in large cities lies in two directions : discourage the use of the automobile (through cost, congestion or legislation) and offer more efficient alternatives (mass transit, car pool, shared taxis, etc.).

Although mass transportation systems are constantly being improved (see for example the automated metros such as the VAL), more flexible means are also needed, in particular at places or times where the demand is too low to justify mass transport. Among these flexible transportation means, we can mention taxis, dial-a-ride mini-buses (or shared taxis) and PRT (personal rapid tansit) which seem to be coming back.

However, all of these alternatives have not proved their economic feasibility and remain marginal. A new concept is now emerging which may offer the same convenience as the private automobile and at a low cost : it is the concept of a self-service-car (also called station car if its main purpose is to complement a mass transit system) : a single public car used several times during the day by different users. Besides, if the vehicles are well adapted to city use (small size, electric engines, controlled speed, etc.), the problems of automobiles in cities may be minimized. This concept is now being developed in France with the PRAXITELE system [l, 2],

However, for these self-service cars to be really attractive as an alternative to the private automobile, they must be available all the time at closely spaced locations. This implies that the cars must be moved according to the demand. Two techniques can be used to move the waiting cars : use employees or use automation or a combination of the two. We believe that a large number of “stations” could be placed along a network of “automated roads” where the cars could move automatically.

Furthermore, these self-service cars could be made available outside the automated network if they are manually driven. This is the concept of “dual mode” developed by INRIA [6].which could allow for door to door service. With some help from employees which would drive the cars to and from the stations which are on the automated network, this system could cover a very large area. Later, when the network of automated roads is sufficiently large, it could also be opened to private cars, as long as they are certified (and probably maintained) by the operator of the network.

PUBLIC TRANSPORTATION ALTERNATIVES

We all know the advantages of mass transportation, be it trains, metros, trams or busses. All these means are highly efficient in terms of number of people transported per unit of space or energy, as long as the demand is sufficient. If the demand decreases, the operation cost remains the same and the system loses money. This is why most mass transit systems stop at night and also sometimes during off-peak hours. This is also why mass transit is not efficient in suburbs to suburb routes : the demand is not sufficient along any particular route because the customers would have to walk too far at either (or both) ends of the trip. Each mass transit system has a certain operating range in terms of passengers per hour which cannot be crossed because of economical constraints (lower bound) or technological constraints (upper bound).

On the other end, we have the private automobile which is very efficient in a different range of demand. As long as the demand is low, cars and roads are an efficient system for regular transportation of people or goods. However, when the peak demand exceeds a certain density, congestion sets in and even with the construction of expensive infrastructures such as urban freeways, the economics of road transport deteriorate rapidly. Furthermore, many undesirable effects are added such as air and noise pollution.

If we want an efficient alternative to the private automobile, we must provide a public transit system which offers the same level of service. This can only be achieved through a combination of mass transit for the high flows and flexible public transport for the times or places where mass transit is not appropriate. Existing flexible systems are : taxis, dial-a-ride services, self-service cars and PRT.

l- Taxis

Taxis have to face several problems. The most important is certainly the problem of the demand level. If the demand level is not sufficiently dense, it means that each taxi has to reach a much greater distance (bad for economics and for service time) or accept to make very few trips per day. In this latter case, this activity can only be a complement to other activities and cannot justify itself economically (this is seen in rural areas where the taxi driver can have another job).

The second problem is the demand allocation. If several taxis operate in the same region (which can be good for economics and for service), some form of allocation must be made. Until now this is either done by roaming, or by queuing, or by dispatch. The main problem with these approaches is that they are probably not optimal in the sense that the taxis are either too numerous, or not enough, or not at the right place. All this means that the economics are not very good (taxis wait for customers) or the service is not very good (all taxis are busy or too far away). New computer-based systems using GPS localization and digital communications try to bring some form of better management but the major problem is the cost of the driver when the taxi is empty.

2- Dial-a-ride services

These services have been put into place more than 20 years ago to replace bus lines in low density zones or time periods. Instead of running the busses regardless of ridership, it was decided to run them only according to the demand. Furthermore, the line could be changed according to the demand. Actually, all the lines could be fictional and the customer would have the possibility to go from any place to any place (as with a taxi) but without any guarantee on the time taken and of course not in a private way.

A major problem is the complexity of the routing problem if one consider the more complex system of door to door (or even station to station) transport in a large environment. However, these problem can now be solved efficiently with current low cost computer technology. The main problem however, remains the cost of running such a system. If the demand is too low, it will not pay for the cost of immobilization of the vehicle and its driver. This explains why such systems are not commonplace and often reserved for reduced-mobility persons.

3- Self-service cars

The concept is based on a fleet of cars which are available to a set of suscribers in specific « stations » for use in restricted areas. At the end of the trip, the car is left in another station. The cars are available 24 hours a day and the fare is based on the time the vehicle is used and eventually the distance it travels.

These systems are in the planning stage for demonstration in several cities in Europe [4-6]. In America, a similar principle is also being tried with « station cars » which are aimed mostly at the end trip to or from a mass transit system. The technological advances concern the electric car which is favored by city officials who want to rid the city of polluting cars, smart card technology which allows simple access control and billing, positioning of the cars by GPS to keep track of their location and digital communication with mobiles for the management of the cars.

The main advantages of this system are the following :
- relatively low investment limited to the acquisition of cars, the installation of the parking lots and the management center,
- relatively low operation cost since the cars do not cost much when they are waiting,
- good quality of service as long as the stations are close to the potential demand and the system is properly dimensioned,
- very good comfort and privacy, close to that obtained with a private automobile, without the constraints of ownership,
- good image for the city and for the user if the cars are electric.

On the other hand, the system has some disadvantages :
- one needs to have a driver license to use the system (not accessible to youngsters and to disabled persons),
- does not work economically if the demand is too low or too pendular.

4- PRT

The concept of PRT is very old and the first experiments took place - namely in the USA - in the sixties. The ambition of the PRT is to offer a public service with the same convenience as the private car :
- large number of stations, even in low density zones, so that one does not have to walk far to get a car,
- good interconnection between lines so that the travel time is minimized,
- automatic vehicles so that anyone can use them and also get high throughput on the line,
- small vehicles allowing comfort, privacy, and low operation cost.

The constraint of automatic driving imposes the choice of a dedicated track, completely separated from traffic and pedestrians. This constraint brings the major difficulty of the concept : how to build these dedicated tracks. The obvious solution is to make them elevated but this is costly and brings lots of resistance from people living nearby. Underground solutions are also very costly and not as nice to the riders. As for tracks at ground level, this brings the problem of the ((barrier effect)) which cannot be accepted all over a city.

Besides the cost of the tracks, the PRTs are also faced with the cost of the vehicles and of the control systems. Equivalent systems such as the VAL in France (an automated light rail) show that these costs cannot be underestimated and this will bring the cost of each car way above the cost of a standard automobile.

5- Synthesis

Here is a synthesis of the various individual public transportation means in the city :

	Taxis	**Dial-a-ride**	**Self-service**	**PRT**
Investiment cost	low	low	moderate	high
Operation cost	high	high	moderate	moderate
Performance*	low to high	low to moderate	high	high
Comfort	high	moderate	high	high
Accessibility**	high	moderate	moderate to high	moderate
Disabled persons	not welcome	special services	not possible	yes
Fare	high	low to medium	medium	medium

* waiting time + travel time
** distance to walk at each end of the trip

AUTOMATED PUBLIC CARS

Our own concept is to combine self-service cars with PRT technology in order to offer automated travel where the flows can be high at certain periods and manual travel locally next to the automated network.

With the development of assisted and automated driving techniques, it is now feasible to consider the possibility to move cars automatically on paved roads between stations where they can stop and move to the normal road network. If the speed is limited (to say 15 km/h), the road does not even have to be protected. This means that stations can be on level ground and hence be very inexpensive compared to aboveground or underground stations needed with PRT. For higher speeds (for example between stations), it will probably be necessary in densely populated areas to have a protected network which could for example double an existing highway network.

The development of these automated vehicles could come from three different directions. The main and obvious one is the development of driving assistance and automation in regular cars. very rapid progress has been made in the last five years and there are many operational prototype cars now available which can drive autonomously on paved roads with a minimum of infrastructure. All these developments are now labelled ‘Automated Highway Systems” (AHS) but car manufacturers, highway builders and governments are wondering how to introduce such a technology on a wide basis. Recently, researchers from Berkeley have proposed that a public transit authority could be the first user of such a technology in the most congested cities.

The second direction may come from the transit industry. In Europe, the concept of “intermediate transit” is uner development with mass transit systems which could fill the gap between busses and light rail. The idea is to have a kind of small tram (possibly electric or hybrid) but on wheels. These vehicles would be (at least on some part of the trip) guided on a dedicated track. In order to minimize the infrastructure cost, the guiding technology under development would be non-contact. This is the case of the CMS project under development by Renault and Matra in France.

The third approach is to develop a new type of vehicle dedicated to this concept. This is what has been done at INRIA with the CabbyTM vehicle. This vehicle represents the first prototype of a new generation of vehicles completely under computer control but with a possibility of manual driving through the computer (drive by wire). The Cabby has been designed specifically as a public vehicle with manufacturing and maintenance costs in mind. This first generation of public vehicle has been aimed specifically at small distance and low speed trips that can be found for example in pedestrian areas such as those in historic cities. Other types of vehicles (larger and faster) can be derived directly from this model, the controls being the same.

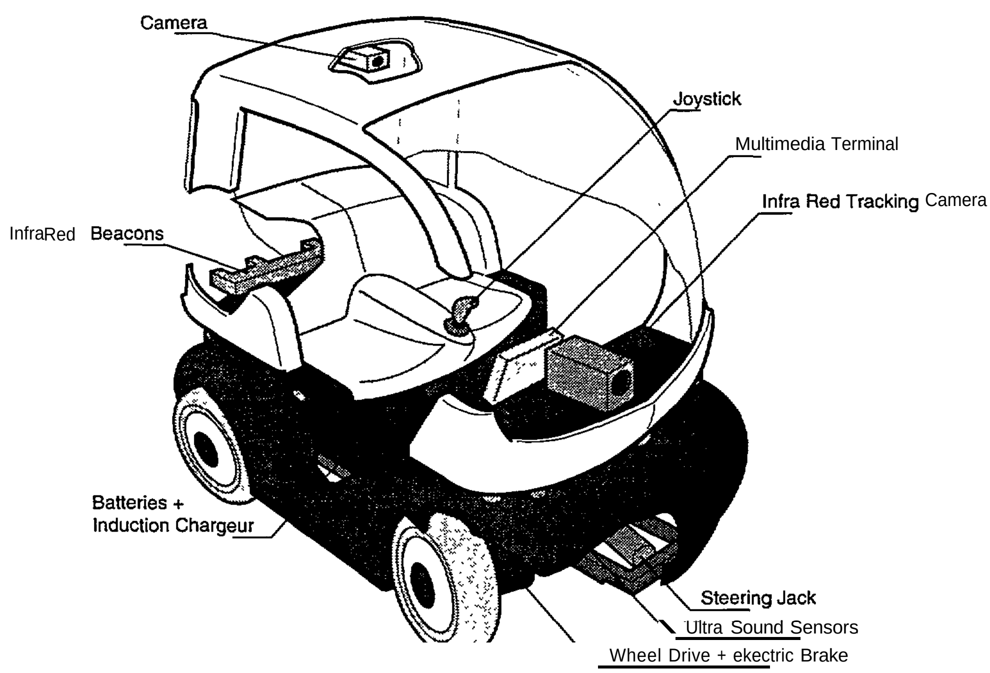

Fig. 1 : The CahbyTM vehicle

The vehicle can now be driven either manually, or teleoperated (7), or driven in platoons with a single driver. We are now developing the techniques for autonomous driving on dedicated tracks using magnetic or optical (or both) markers on the road.

THE AUTOMATED ROAD NETWORK

The challenge is now to define where these computer controlled vehicles could run automatically. The main difficulty is the interactions with other vehicles. The interaction could be minimized if the private cars are banned or accepted at very low speed and without any priority as this is already the case in the historic center of many European cities. The automated vehicles could also be restricted to operate in the automated mode only on locations where these interactions can be avoided such as special lanes parallel to main throughways. In the case where the automated cars must cross regular traffic, there can be an overpass or underpass which would be of very small size since the public vehicles will be rather small and non polluting. Another alternative would be to have a level crossing protected by street lights associated with a video monitoring of the intersection.

We can see that we have a trade-off between restricting the use of regular cars and making special infrastrucures dedicated to the automatic cars. However, this problem has alredy been studied in many places where a priority to mass transit has been decided. In many cities (in Europe in particular), the circulation of private cars has been severely restricted to offer priority to light rail or busses. Similarly, dedicated lanes for busses are more and more set apart in order to give an advantage to mass transit over the private car.

This strategy of giving priority to mass transit can be justified on the grounds that space is used more efficiently and nuisances are minimized. A bus on a dedicated lane requires about 300 m of bus lane at peak time (one bus every minute at 5m/s) for 50 passengers or about 18 square meters for 1000 seconds per passenger for a 5 km trip. The same passenger using a car would need about 20 meters of lane for the same amount of time plus two (or more) parking spaces of about 30 square meters (including access ramps) for a total of 24 hours. The space-time factor would then jump from 18,000 to 60,000 just for the trip plus 43,200 for parking (parking space for a bus is negligable considering the total number of passengers it carries). Car pooling aims at divising this enormous space-time factor by 3 or 4 and hence making it close to bus on a dedicated lane. Of course, a light rail would have a much smaller factor as long as the frequency remains the same and the capacity of the train is increased largely.

Now, during off-peak times, the busses must seriously decrease their frequency in order to have a reasonnable cost per passenger. They may even stop altogether at certain times of the day or the night. This is where the automated public cars could take over.

Since the lane already exists, the cost of the equipment to make it an automated lane would not be very high if there are not too many crossings which must be transformed by under or overpasses or protected by special lights. This could then provide at fairly low cost a high quality service which would run 24 hours a day on demand without requesting more space.

Furthermore, if the vehicles are designed to be shared at peak time, they could advantageously replace the busses. Indeed, if we have an average of 4 passengers per car and cars are platooned in packs of 20 (as it is envisioned in the automated highway systems) with interdistances of 300 meters, this would mean a capacity of 4,800 passengers per hour instead of 3,000 with the busses, if the speed is the same. Besides, the average speed could be increased if the cars stop only when and where needed (they would be derived from the main flow). Advocates of the automated highway even consider as possible, maximum flows of 6,000 cars per hour at speeds of 100 km/h but this does not seem realistic in an urban environment with many stops.

REFERENCES

[l]- Laramee Michel, Benejam-Francois Evelyne. « PRAXITELE. Pour un Transport Public PRAtique Individuel ELEctrique » Textes des Communications de la Journee CFE. La Rochelle, Novembre 1993.

[2]- Parent Michel, Dumontet Francois Texier Pierre-Yves and Leurent Fabien. « Design and Implementation of a Public Transportation System Based on Self-Service Electric Cars » IFAC/IFORS Congress. Tianjin, China. Aug. 1994.

[3]- Augello Daniel, Benejam Evelyne, Nerriere Jean-Pierre and Parent Michel. « Complementarity between Public Transport and a Car Sharing Service » First World Congress on Applications of Transport Telematics & Intelligent Vehicle-Highway Systems. Paris, France. Nov. 1994.

[4]- Allal Chafik, Dumontet Francois, Parent Michel. « Design Tools for Public Cars Transportation Systems » Fourth International Conference on Applications of Advanced Technologies in Transportation Engineering. Capri, Italy. June 1995.

[5]- Daviet Pascal, Parent Michel. « Platooning for Small Public Urban Vehicles » Preprints of the Fourth International Symposium on Experimental Robotics, ISER'95 Stanford, California, June 30-July 2, 1995.

[6]- Parent Michel, Fauconnier Sylvain. <<Design of an Electric Vehicle Specific for Urban Transport » Congres EVT'95. Paris, Nov. 1995.

[7]-Bensoussan Stephane, Parent Michel. "Computer-aided teleoperation of an urban vehicle". ICAR'97. Monterey, USA. July 1997.

Economic Evaluation of Chauffeur

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OBJECTIVES

For a successful implementation of CHAUFFEUR it is essential to get a clear picture about the private and public rentability.

Therefore, it is necessary to prove the system’s profitability to potential users on a micro-level, Convincing potential users of CHAUFFEUR ‘s advantages is a prerequisite for its acceptance by these user groups. First of all, interests of the operators and transport firms must be taken into consideration. On a second level requirements of road operators must be integrated in the CHAUFFEUR concept and last not least the successful implementation of CHAUFFEUR systems relies to a high extend on complementary political aspects.

Fleet and freight operators firstly expect cost savings, if they invest in new technologies. They will not accept any new technology, if the initial investments costs and additional operating costs are not considerably exceeded by the resulting savings. However, for CHAUFFEUR systems substantial savings can be expected resulting from lower personal and vehicle operating costs (e.g. fuel consumption). But the willingness to invest in new technical systems is also directly linked to the amount of organisational changes, which are necessary for the introduction of CHAUFFEUR systems into their business operation. If there is a need for a considerable re-organisation CHAUFFEUR systems will not be accepted, even by the most innovative companies.

Beside the direct cost savings of using CHAUFFEUR systems, it is necessary that CHAUFFEUR offers also significant cost savings by optimizing routes and load factor. On the other hand from a general economic point of view, it is also necessary to emphasize the advantages of the CHAUFFEUR system by evaluating its contribution to a reduction of road accidents, of road traffic, and of emissions (e.g. pollution, noise). Therefore, cost-benefit-relations must be derived.

For rentability analyses on a macro-level two approaches come to mind:

- Cost-benefit-analyses consider the real economic effects to quantify the savings of resources.

- Cost-effectiveness-analyses are more open to the consideration of divers aspects of impacts and utilize physical success indicators which are obtained through scoring models based on surveys.

MODELLING

Working with empirical cost-benefit-calculations requires the specification of the relevant and complex multi-dimensional relations of reality in a comprehensive model to connect data, interrelation of effects, monetary assessments of effects, and rentability criteria.

For this purpose a traffic simulation model is used that was adjusted to the specific needs of the research objectives of the CHAUFFEUR-project.

TESTS AND EVALUATION

COSTESTIMATIONS

Until now it was only possible to undertake rough cost estimations. Table 1 gives an overview over the first estimation of investment costs depending on different share of usage. Operating costs and investment cost for the enlargement of road infrastructure can be calculated if the technological development of CHAUFFEUR is more advanced.

Table 1: CHAUFFEUR-system cost for different equipment rates of the total truck fleet

Equipment rates (in percent.)	System costs (in Million DM)
20	261,17
40	522,34
80	1.044,68

BENEFIT ESTIMATIONS

The main effects of CHAUFFEUR systems come from the better usage of road infrastructure capacity. This effect leads directly to savings of time costs, vehicle operating costs, and emission costs. The cost-benefit analysis is based on two scenarios. Scenario A estimates the capacity effect of CHAUFFEUR system for an equipment rate of 20 percent, and scenario B for 80 percent.

This evaluation has to be enlarged on two other effects of CHAUFFEUR systems. First of all, CHAUFFEUR enables the possibility to reduce the fuel consumption of the second vehicle. This lowering fuel consumption directly caused by CHAUFFEUR has general effects. First the vehicle operating costs of transport firms will be lower because of fuel savings (micro-level). Second, the society benefits from this effect because air pollution will be also lower (macro-level). The second main effect of CHAUFFEUR system will be that the accidents between trucks could be lowered.

RESULTS OF THE ECONOMIC EVALUATION

Table 2 and 3 give an overview over the costs and benefits coming the CHAUFFEUR system with respect to the different equipment rates of the total truck fleet.

Table 2: Cost-benefit-analyses of CHAUFFEUR system (Scenario A)

	Valued effects	(in Million DM)	Total (Million DM)e
Benefits	Capacity effect	2.134,21	2526,92
	Direct fuel savings	359,90	
	Accident savings	32,81	
costs	System costs	261,17	261,17
Cost-benefit-ratio			**9,68**

Source: own calculations

+

Table 3: Cost-benefit-analyses of CHAUFFEUR system (scenario B)

	Valued effects	(in Million DM)	Total (Million DM)
Benefits	capacity effect	**2387,55**	3958,72
	direct fuel savings	1439,60	
	accidents savings	131,24	
costs	system costs	1044,68	1044,68
Cost-benefit-ratio			**3,79**

Source: own calculations

ITS
Intelligent Transport Systems

Asia-Pacific Projects Status and Plans

The First International Workshop on Vehicle Highway Automation

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Agenda

ITS

1. Asia-Pacific Projects Status and Plans
   1) Australia
   2) Korea
   3) Taiwan
   4) Japan
2. AHS Strategy of Japan

   To provide points for discussion regarding AHS

Research activities conducted in 70's and 80's

ITS

Research of autonomous vehicles using machine vision

Research of collision warning technology

80's

Research into Intelligent Cruise Control

Research into enabling technologies
- roadway sensing
- laser radar
- vehicle control
- vehicle to vehicle communication

Automated vehicle developed in 1977

ITS

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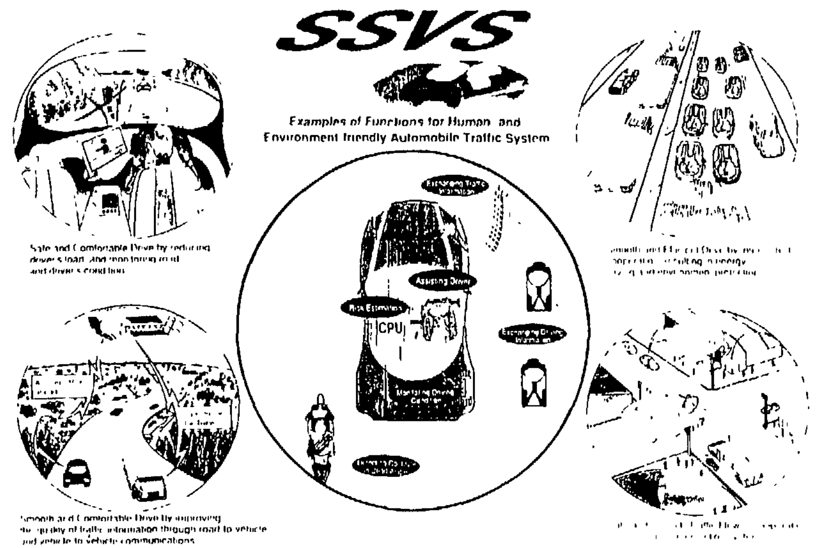


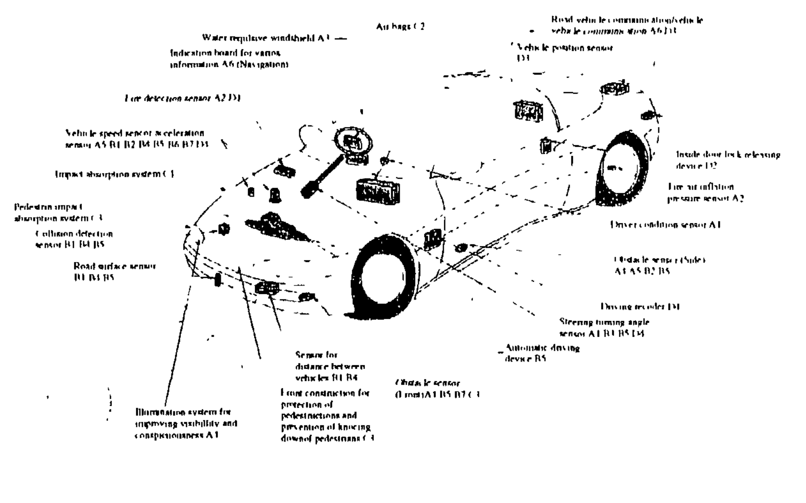
Beginning of AHS

1989 ・・・ Beginning of research and development of AHSS(Advanced Highway Safety System)

1991～93 Joint research
PWRI and HIDO (Highway Industry Development Organization)

1994～96 Joint research
PWRI,HIDO and 24 private companies

ASV



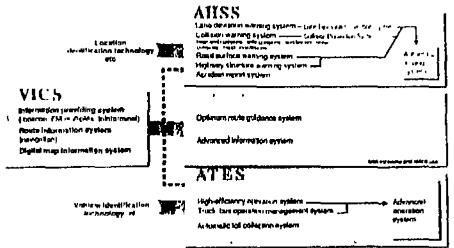
Authorization of the plans

AHSS's three-phase evolution
1 Warning System
2 Prevention System
3 Automatic Driving System

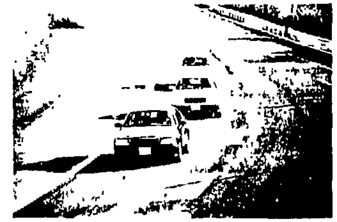
The AHS project was authorized

AHS's three-phase evolution
1 Danger Warning
2 Assistance for Driving
3 Automated Highway Systems

Roads in Japan 1993



Operational demonstration tests on the test course of the Public Works Research Instiute in 1995



Public announcements of research results

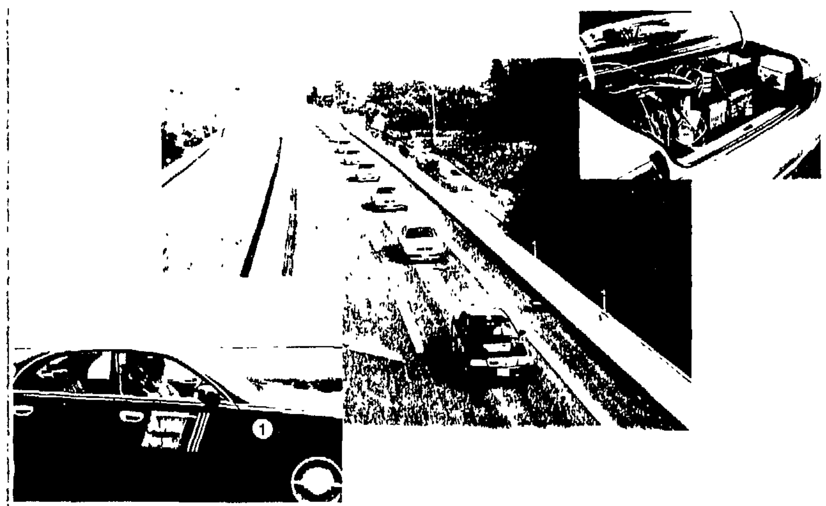
AHS Operational demonstration tests in November 1995

- The 3 km test course of the Public Works Research Instiute
- Vehicle control in both the lateral and longitudinal directions
- 250 observers from 7 countries attended the test.

AHS Operational demonstration tests in September 1996

- An 5.4 km section on the expressway between Tokyo and Nagano
- Danger warning / Assistance for driving / Automated highway systems
- 1,300 observers from 14 countries attended the test.

Operational demonstration tests on the Joshin-etsu Expressway in 1996



Improvement of research systems

AHSRA was established in September 1996

Advanced cruise-assist Highway System Research Association

- Twenty-one companies participate in the association
- Road-vehicle cooperation
- 120 organizations have been registered as associate members
- Three-phase research and development
  1. AHS-i (information)
  2. AHS-c (control)
  3. AHS-a (automated cruise)

Definition and name of ITS

Definition of AHS

Fully automated driving ?

AHS-i,c,a ?

Name of AHS

Vehicle Highway Automation ?

Advanced cruise-assist Highway ?

Future research and development plans

Comprehensive Plan for ITS (1996)

- AHS-i and AHS-c

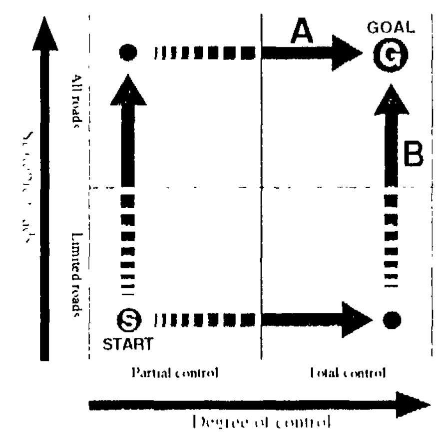
  "Practical Use around 2000"

- AHS-a

  "by the beginning of the 21st century"

The new Five-year Road Improvement Program (1998-2003)

Two Processes to achieve fully automated driving



Subsystems of AHS

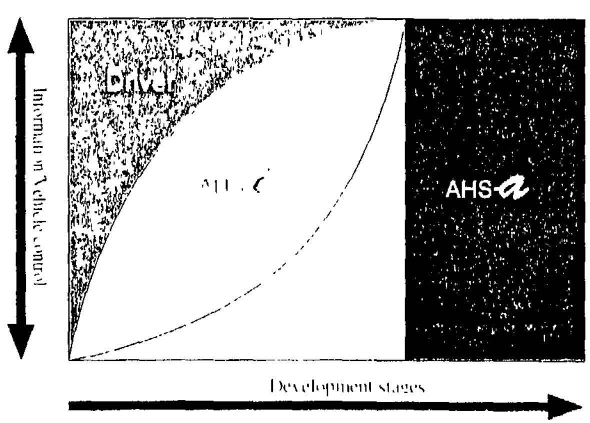
ITS

Role sharing

	[illegible]			[illegible]
Information		System	System	System
Vehicle control			System	System
Responsibility				System

AHS Evolution

ITS



AHS -AUSTRALIAN PERSPECTIVE

By: Dr A P Ockwell

Presented to: First International Workshop On Vehicle-Highway Automation

San Diego, California
11-12 August 1997

AHS - AUSTRALIAN PERSPECTIVE

- Australia does not have any current plans to develop an Automated Highway System. However, Australia is utilising various ITS technologies to address many of the transport problems facing the nation.

- Booz-Allen Hamilton has undertaken a survey of Australian firms in the ITS industry on behalf of ITS-Australia (ITS A). The purpose of the survey was to derive a profile on the capability of the local industry to contribute to expected growth areas in ITS. From the survey, it was clear that a number of firms are involved in the development of component technology relevant to AHS.

- The following statistics are worth noting:

	Units	Australia	USA	Ratio-USA to Australia
Area (km)	mil.	7.7	9.4	1.2
Population	mil.	18.1	262.8	14.5
Road Netwk	'000	810	6.285	7.8
Vehicles	mil.	11.0	192.3	17.5
Fatalities		2,017	41,798	20.7

(OECD statistics 1995)

- While both countries are similar in size, the USA has over 14 times the population and seventeen times the number of vehicles. So while some of Australia's capital cities have significant congestion problems, it is probably true to say that other ITS options are being implemented in an attempt to address these problems.

- It has been estimated that the annual cost of congestion in Sydney and Melbourne is some $A4 billion, with business bearing about 70% of these costs. Consequently, there are significant economic gains to be realised from reducing this level of congestion and Australia recognises the potential that ITS technology offers in this regard.

ITS TECHNOLOGIES

- Australia has been in the vanguard of ITS development and our world renowned traffic management system SCATS (Sydney Coordinated Adaptive Traffic Control System) was developed in the 1970’s and has been exported to nine countries including Singapore, Hong Kong, Ireland and several States in the USA.

- In two of Australia’s main cities, Sydney and Brisbane, electronic toll collection (ETC) technology is being adopted. In Sydney, ETC technology has been on trial on the Harbour Bridge for some years, while the recently opened M2 Hills Motorway (22km) offers motorists the opportunity of utilising ETC technology. Brisbane offers its motorists ETC facilities on the Gateway Bridge.

- The Melbourne City Link Project (22km) due to be operational by 1999 will be fully electronic and travel times are expected to be reduced significantly along with congestion costs.

- Developers expect some 600,000 tags will be issued at no cost to motorists when the Project is operational.

VEHICLE IDENTIFICATION AND TRACKING SYSTEMS

- Melbourne's transport agency, VicRoads, has entered into a partnership with the Victorian Road Transport Association and the City Link Authority to undertake a real time tracking system using electronic tags in vehicles. The trial offers significant potential in areas of reduced urban congestion and transport costs.

- Australia is well aware of the need to entice motorists out of their cars and into public transport. A number of initiatives in several Australian cities are increasing the attractiveness of public transport. In Sydney, for example, passengers travelling between the city, Kings Cross and the domestic and intentional terminals can access real time travel information to assist them in making more informed travel decisions.

- The Brisbane City Council has introduced a bus priority system using transponders on buses to provide real time travel information and to give buses priority at traffic lights.

- Australia has been well aware of the potential ITS offers in the area of safety and many applications have been adopted to enhance the safety of road users.

- The advantages of tracking systems are well recognised in Australia. One particularly effective example of this technology is Safe-T-Cam which is being used for monitoring heavy vehicle movements at nine different highway sites in the State of New South Wales. Safe-T-Cam has been instrumental in increasing safety and has been well received by the heavy vehicle industry, as a means of tackling fatigue and speed.

- The taxi industry has been quick to adopt tracking systems because of the benefits on offer in the areas of more efficient dispatch, security and safety. A number of freight forwarders are utilising this technology to protect high value cargo, while roadside assistance organisations are utilising global positioning technology to improve their service to the motoring public.

- Variable message signs are increasingly being used in Australia to provide information to motorists on traffic conditions on major roads. Vehicle detectors collect traffic data in real time to provide travel time and incident information. When motorists reach the UBD parking guidance systems in some cities advise on the availability of parking.

- Variable message signs are also being used on some highways to alert motorists to changing driving conditions, such as fog. Furthermore, these intelligent signs can warn individual drivers that their speed is in excess of the speed limit as well as advising that a collision with a vehicle ahead is likely if that vehicle is travelling slowly.

- In 1992, ITS Australia was established as a joint endeavour between government, industry and academia to encourage the development and application of ITS technologies in Australia. ITS-A is being used by the Federal Government as an expert advisory group on ITS matters and has requested it to assist in developing a draft national standard for ETC that will form the basis for future implementation of ETC systems throughout Australia.

- In Australia, some 270 organisations are involved in ITS technology and a range of Australian expertise has been exported including traffic management systems and fast ticketing systems.

- Australia has always demonstrated a willingness to embrace new technology and our take up rate of mobile phones, video recorders, microwave overs etc is amongst the highest in the world.

- We are a highly innovative nation and have much to offer in specialist areas of ITS to improve transport efficiency and safety. But we are also anxious to learn from the experience of others and the AHS offers a unique opportunity for a sneak preview of what transport in the 21st century will be like.

The ADVANCE-F System in Taiwan

Tang-Hsien Chang

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ADVANCE-F is one of intelligent transport systems (ITS) being studied to improve Taiwan's highway traffic quality and transportation quantity. This project intends to integrate vehicle control and traffic operation in order to upgrade highway capacity, maintain traffic order, enhance traffic safety, and reduce pollution. In 1990-1992, it oriented to be an Automated Highway System (AHS). However, due to executive impedance, the AHS prospect was turned down. Thereafter, the system was changed to be an AVCS (Automatic Vehicle Control System) study only. Currently, the ADVANCE-F project has subjects of developing a reasonable, multitude-affordable and reliable automatic steering mode, autonomous intelligent cruise controller, collision warning/ avoidance system and advanced traveler information system

Figure 1 shows the scheme of the ADVANCE-F system

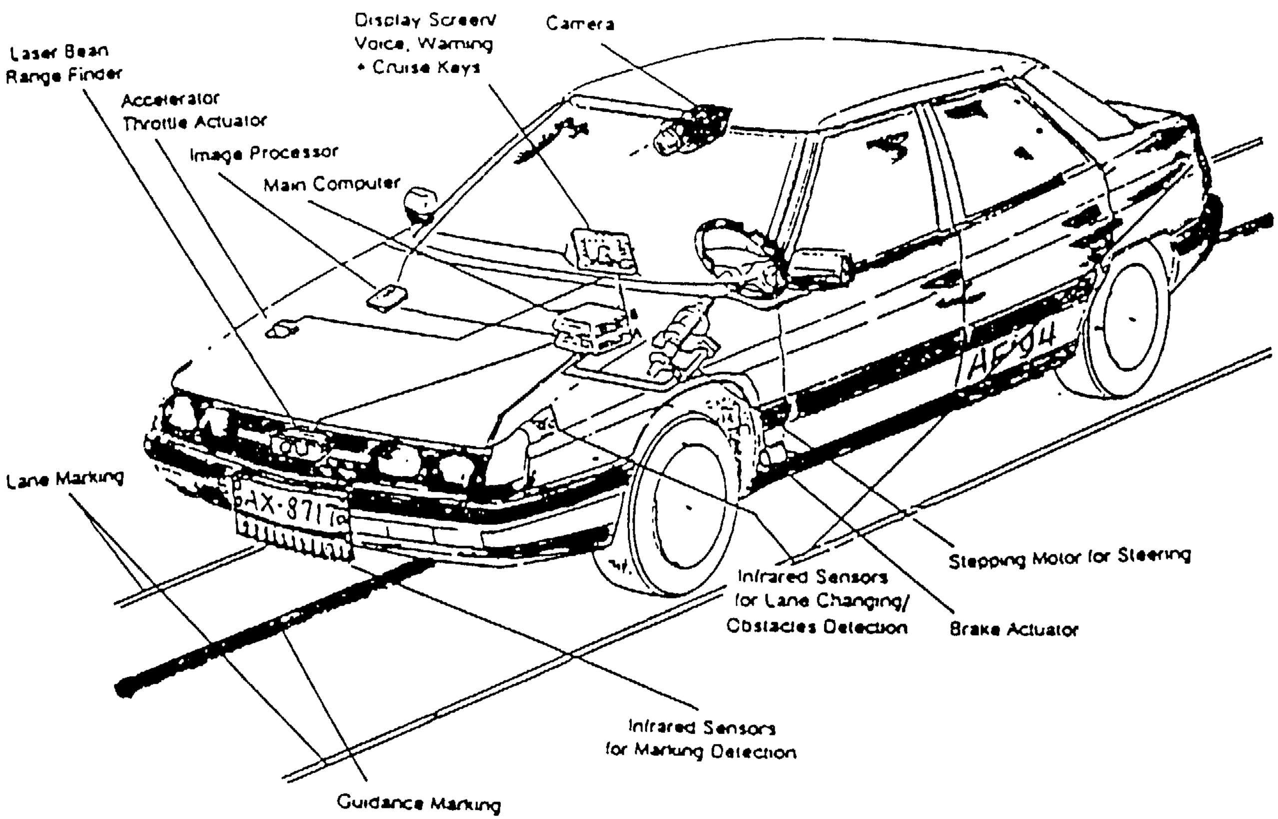
Figure 2 illustrates the frame of the automatic steering mode, which is being tested on field. The ADVANCE-F automatic steering device has function of keeping the equipped vehicle along a particular material-marked lane without manual handling.

Figure 3 shows the autonomous intelligent cruise control unit being conducted, which is modified from the conventional cruise system A remote cruise control function has been accomplished. Platooning policy is also being simulated. In a study of highway simulation with the ADVANCE-F equipped vehicles, it reveals that the system will make highway capacity increase 30%.

Figure 4 illustrates the active control of warning and collision avoidance. However, this mode is under developed.

Figure 5 illustrates there are six ways for the selection of driving such a vehicle.

High quality and high performance vehicles and highways are topics of intense interest around the world. Since the effort of human in ITS study, tomorrow's traffic will become better without doubt.



Driving Alternatives: Steering options—< Manual, Automatic >
Speed options—< Manual handling,
Conventional Cruise Keys,
Autonomous Intelligent Cruise Control,
Central Hazard Avoidance Remote System >

Figure 1. The scheme of the ADVANCE-F system

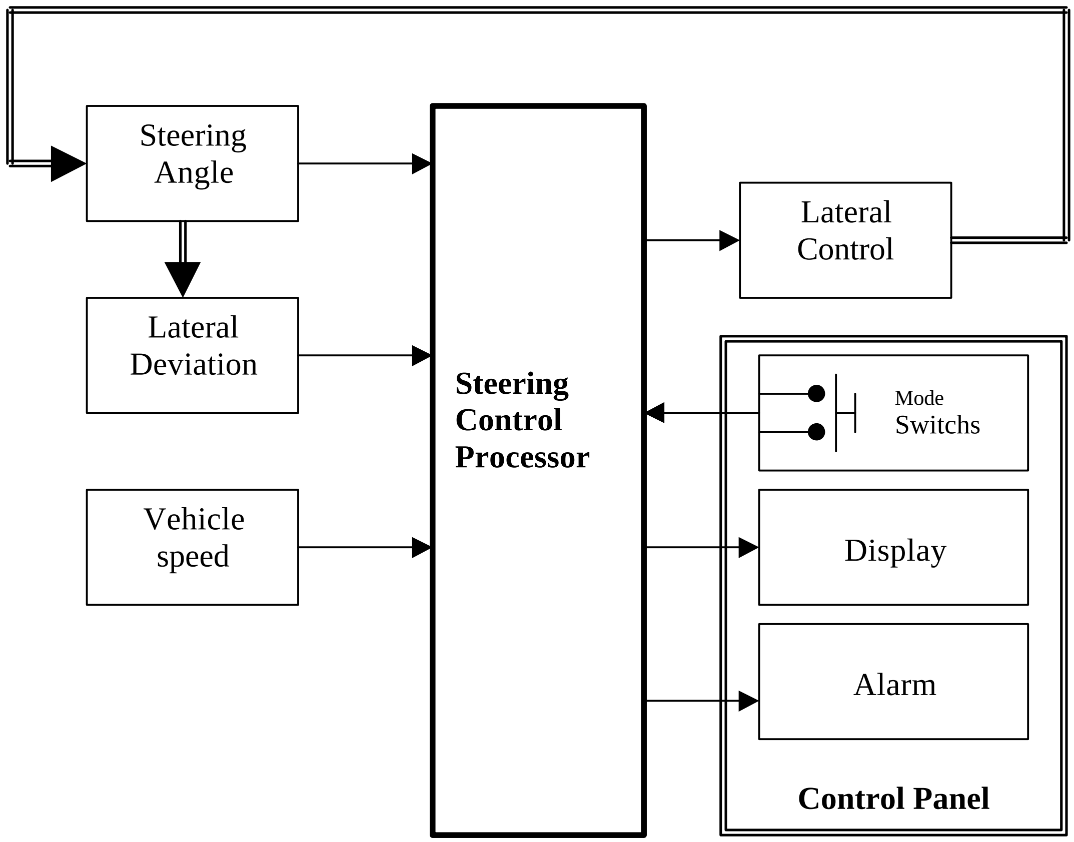


Figure 2. ADVACE-F Automatic Steering control Frame

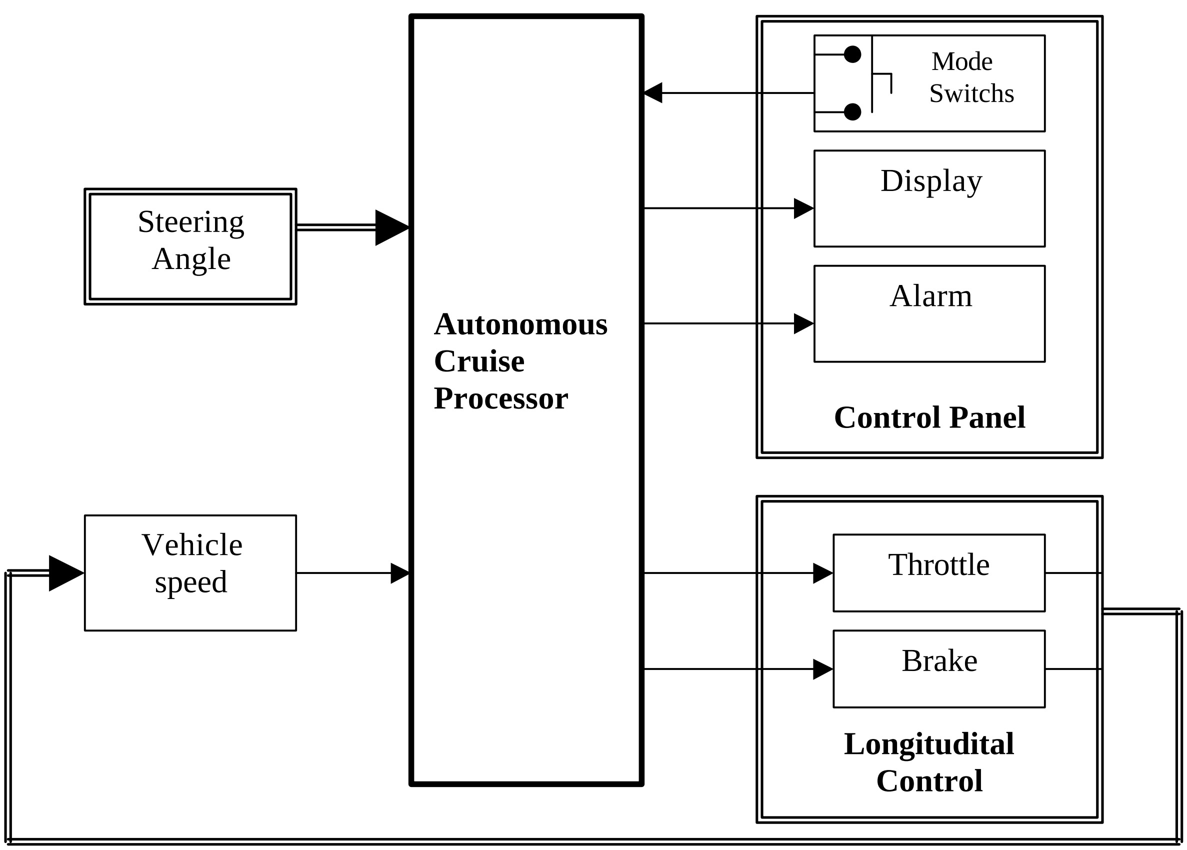


Figure 3. Autonomous Intelligent Cruise control Unit

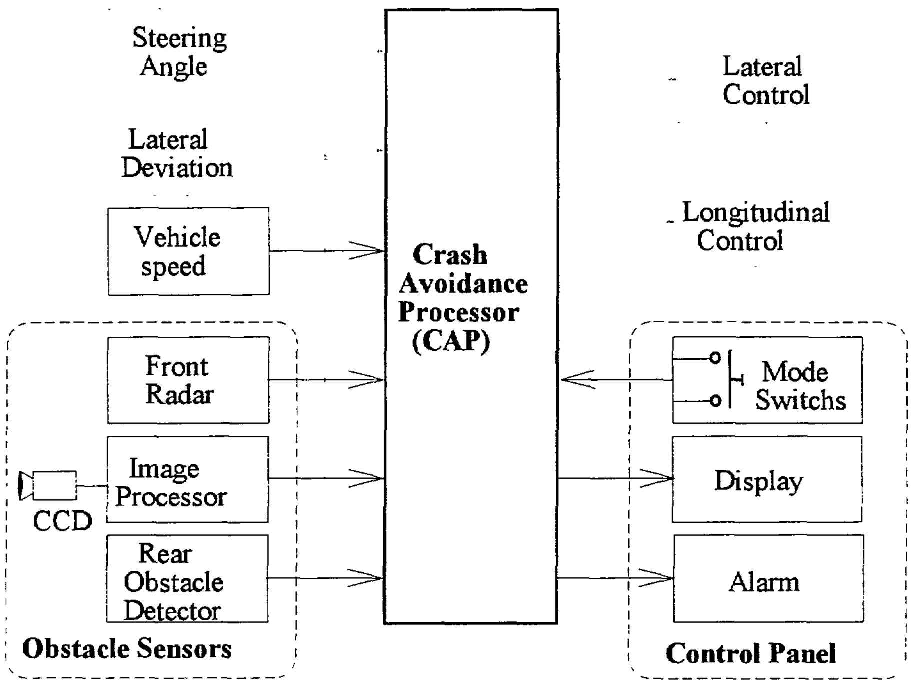


Figure 4. Crash Avoidance Mode

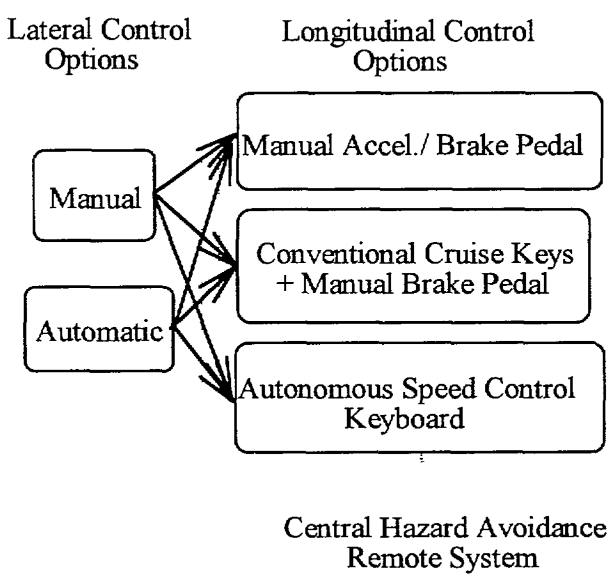


Figure 5. Driving Options by ADVANCE-F

Vehicle-Highway Automation Activities in the United States

Dick Bishop
Program Manager
Vehicle-Highway Automation R&D
US Department of Transportation

August 11,1997

Attachment # 11-4-B

Areas of Activity

- Automated Highway Systems
- Intelligent Vehicle Initiative
- Pavement Testing
- Vehicle Testing
- Off-highway

Intelligent Vehicle Initiative

- **Vehicle Platforms:**
  Car, Truck, Bus,
  Special Vehicle (snowplows, police cars, etc.)

- **Levels of Capability:**
  Level One: information and warning
  Level Two: intervention and driver assistance
  Level Three: adv. driver assist & automation

Intelligent Vehicle Initiative (2)

- **Operational testing of first generation vehicles envisioned during NEXTEA era**

Car:	Level One
Truck:	Levels One & Two
	(Level One on the market)
Bus:	Levels One & Two
Special Vehicle:	Levels One & Two

Pavement Testing

- **Nevada: WesTrac**
  - -- Full size driverless trucks in continuous operation.
  - -- Technology: wire-follower (cable buried in pavement)

- **Minnesota: MnRoad**
  - Full size autonomous trucks
  - Technology -- precise differential GPS

Vehicle Testing

- Chrysler Chelsea Proving Ground "root" driver

Off-Highway

- **Houston: Bus Maintenance study**

- **Norfolk: Port Operations study**

- **Freight Terminals**
  -- Truck distribution facilities
  -- Port-Highway Intermodal interface
  -- Rail-Highway Intermodal interface

Automated Highway Systems

- Demo ‘97: A magnificent achievement
- Technical feasibility established
- Focus now turns to progressive deployment of incremental building blocks

LESSONS LEARNED ABOUT VEHICLE AND HIGHWAY AUTOMATION - LEGAL ISSUES

Prepared for the First International Workshop on Vehicle Highway Automation

August 11-12, 1997

Stephen N. Roberts

Stephen N. Roberts
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(4 15) 398-3600

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Atta -B

Background on the American Legal System

- Based On English Common Law
- Each New Decision Is Based On The "Precedent" Of Prior Law
- When Statutes Are Passed, They Are Interpreted In The Same Way

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Background on the American

Legal System (Continued)

- Lawyers Advise Clients On What The Law Is By Examining The Statutes And Precedents, And Comparing These To The Current Factual Situation
- Each of The 50 States Has Its Own Legal Precedent

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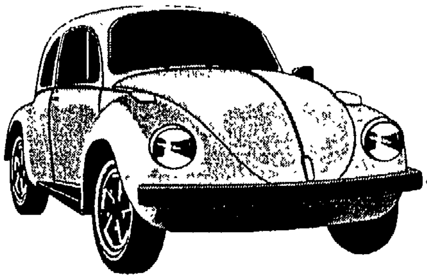
How the Law Is Applied to a New Fact Situation Such As Intelligent Transportation Systems

- Where There Are No Precedents Exactly On Point, Lawyers Will Look To The Nearest Analogy They Can Find
- This Is Especially Important For Intelligent Transportation Systems (ITS)
  - Because ITS Is So New, There Is Almost No Precedent



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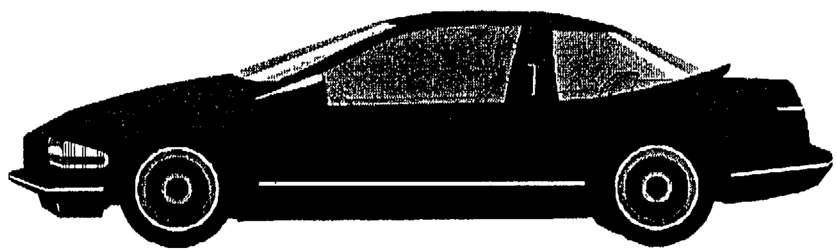
How the Law is Applied to a New Fact Situation Such As Intelligent Transportation Systems
(Continued)

- For Example, For Guidance On Radar Systems In Automobiles, Lawyers Will Look To Past Decisions On Older Cruise Control Designs Another Example, For Guidance On A New Safety Feature In Automobiles, Lawyers Will Look To Cases On Air Bags Or Seat Belts



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Types of Legal Issues Important to Automated Vehicles and Highways

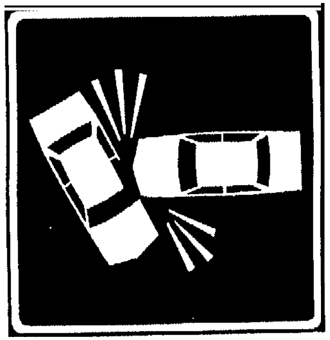
- Liability Issues
  - Insurance
- Contract Issues (Including Procurement)
- Privacy Issues
- Intellectual Property
- Environmental

Liability Law - - Legal Precedent

- There Is No Legal Precedent On Automated Highways Because They Do Not Yet Exist
- Vehicle Automation
  - There Is No Body Of Law Pertaining To The Newest Technologies
  - There Is An Enormous Amount Of Precedent On Such Older Technologies As Air Bags, Cruise Control, Seat Belts, ABS Brakes, Etc.
  - Lawyers Will Have To Make Analogies To Those Older Technologies To Make Recommendations And Decisions About AHS And AVCS

Understanding the Technology

- A Major Problem For Manufacturers And Road Designers Is to Keep The Interface Between Consumer And Product Simple
  - A Complicated Electronic Sign In Dallas Resulted In a Three Car Collision And $20m In Liability



- The Consumer Needs To Be Made To Understand The Technology

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Liability Law - - Studies

- In The Absence Of Legal Precedent, There Have Been Several Reports Written On The Subject
- Liability For AHS And AVCS Has Been Discussed In Numerous Conferences And Workshops
  - In February, A Two Day NAHSC Workshop On The Subject Of Liability Took Place

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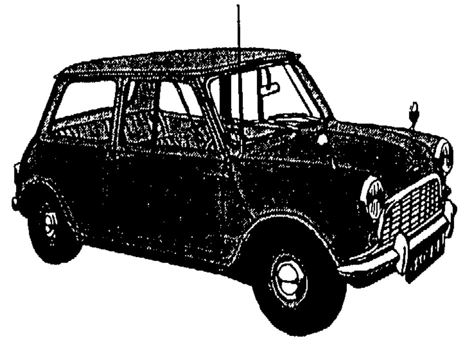
Conclusions From Liability Studies

1. There Is A Great Deal Of Fear Expressed About Liability
   - Some Popular Press Articles Even Characterize It As A "Showstopper" For Automated Highways
2. However, There Is Little Direct Evidence That Liability Will Be Such A Showstopper Or That Such Fears Are Hindering Development Of AVCS or AHS



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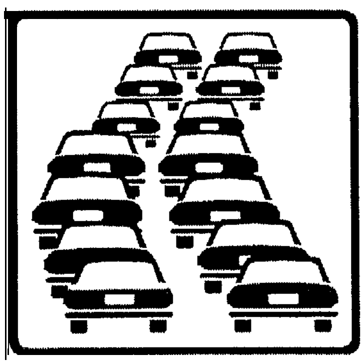
Conclusions From Liability Studies (Continued)

3. Many Such Technologies Have, As Their Goal, Increases In Safety
   - That Fact Should Overcome Many Liability Issues
4. The Biggest Problem Will Be Allocation Of Risk
   - Currently The Vast Majority Of Accidents Are Attributed To Driver Error And Therefore Drivers Bear That Risk



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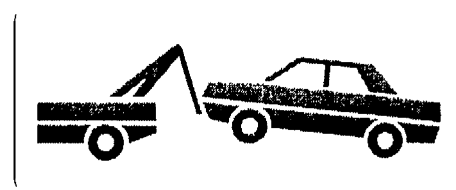
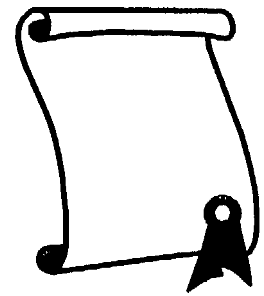
conclusions From Liability Studies (Continued)

- With AVCS (And Especially AHS) Risk Is Shifted To The Manufacturers Of The Technology And To The Designers, Operators And Owners Of The Road
- These Groups Must Find Ways To Allocate The Increased Percentage Of Risk Among Themselves
- If Overall Safety Is Up Sufficiently, The Net Risk For These Groups Might Not Increase



Conclusions From Liability Studies (Continued)

❺ There Is A Need To Work With The Insurance Industry To Develop Appropriate Coverage

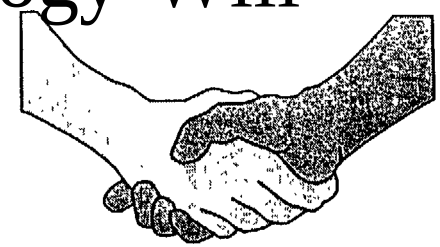


❻ There Does Not Appear To Be Any Current Sentiment For Federal Preemption Of State Law On Liability Issues

– However, On A State By State Basis, Changes
- Can Be Made

Contract Law

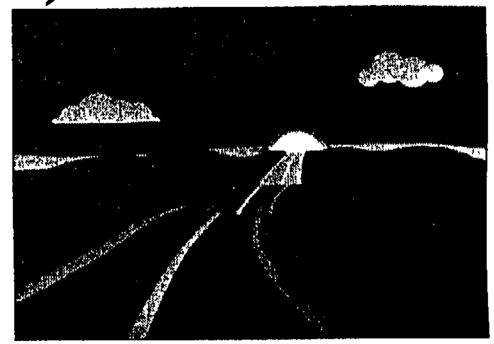
- The Development Of This Technology Will Involve Many Unique Forms Of Public/Private Partnerships



  – There May Be Resistance In Some States From Unions

- Procurement Rules Must Be Adjusted For These New Technologies

Contract Law (Continued)



- Procurement Litigation
  - New Jersey Procurement Litigation
  - <u>Lockheed v. Delaware DOT</u>, 1997 LEXIS 58 (1997)
  - <u>Amtech v. Ill. State Toll Highway Authority</u>, 264 III.App.3d 1095 (1994)
  - Orange County Procurement Litigation

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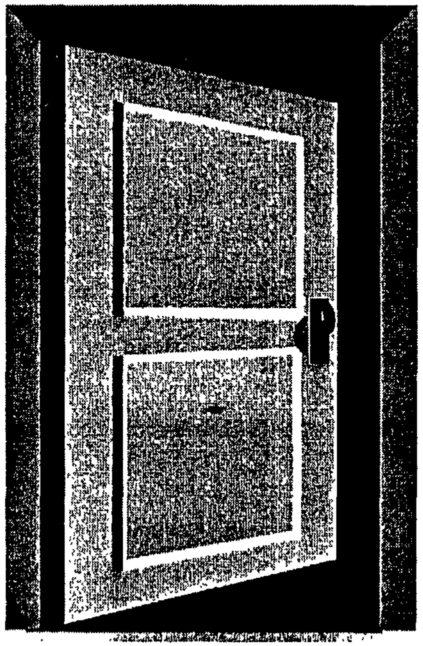
Privacy Issues

- AHS Will Involve Some Privacy Concerns
- Experience With Automatic Toll Collection Demonstrates These Concerns Can Be Overcome



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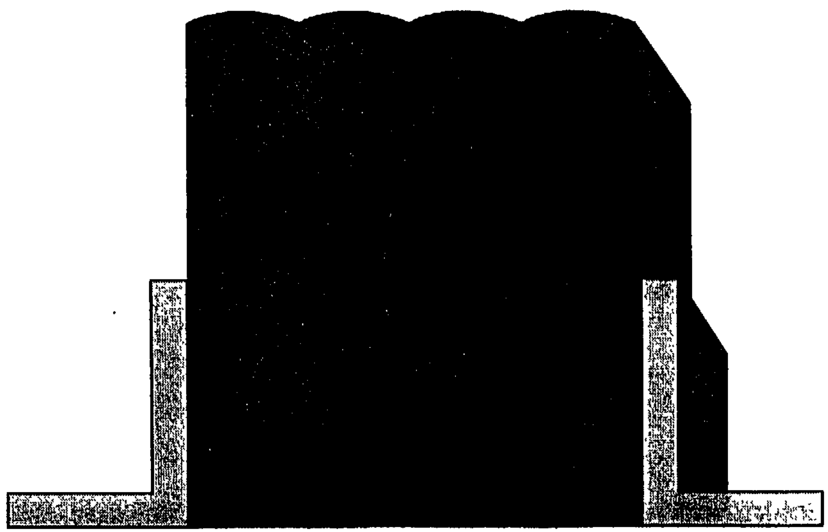
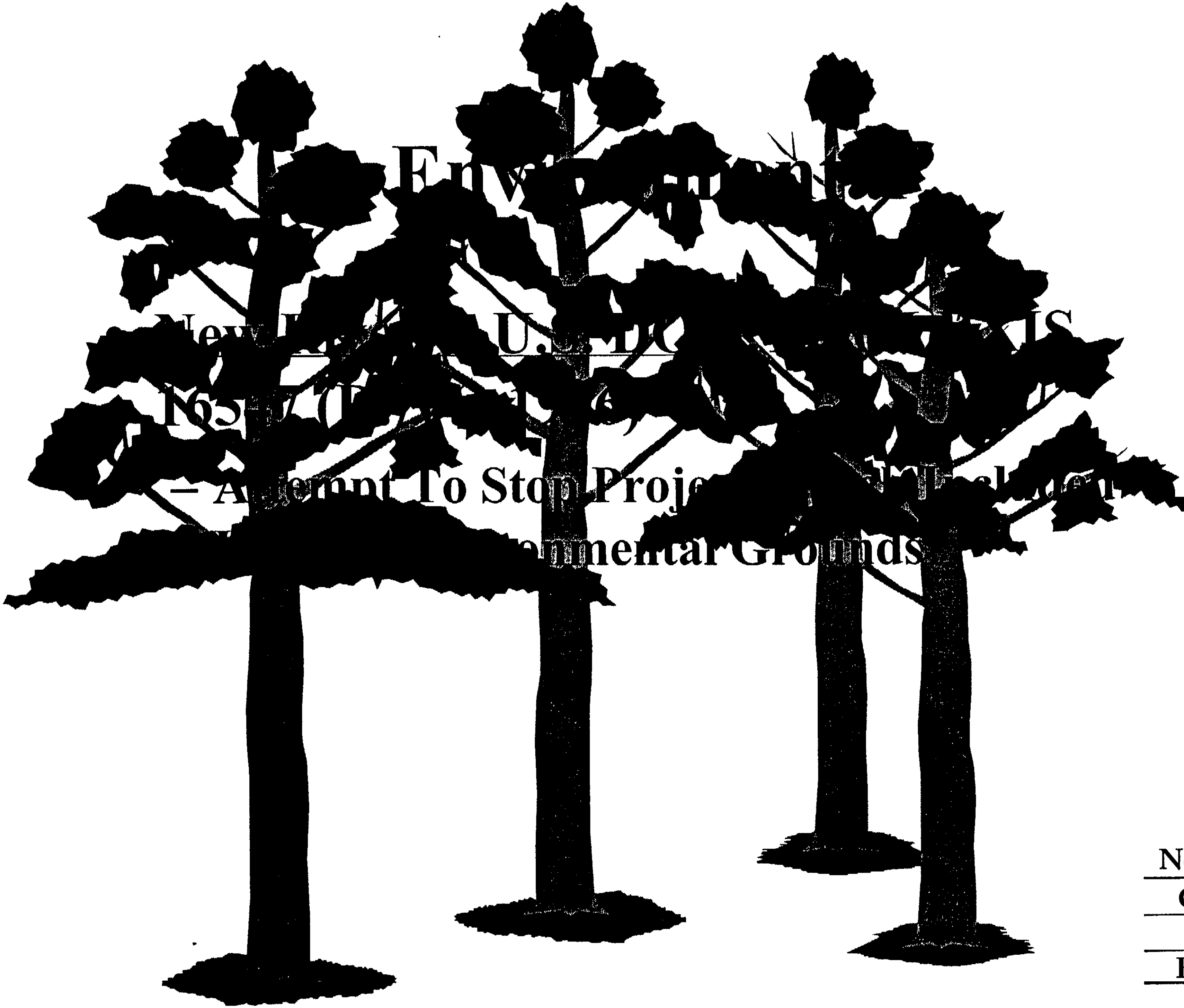
Intellectual Property

- Intellectual Property Issues Are Important Because Of The Sharing Of Infornnation With Government And Other Private Parties





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– A[illegible]empt To Stop Proje[illegible]
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First International Workshop on Vehicle Highway Automation

- Lessons Learned session -

San Diego, August, 11,1997

Dr. Stefan Becker

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e-mail user-center@tuev-rheinland.de

Lessons Learned ....
A lot of questions and some answers

- User Perspective within User Needs and Evaluation Studies
- Experimental Approach: Test Track and Public Roads
- Focus: Longitudinal Control
  (ACC, ACC+, Anti-Collision Assist, Urban Drive Control)
- **User Perspective: Four Levels**

1. Cognitive Level

Comprehensibility of

- functionality:	easy for ,,average“ user
- performance limits:	?
- and operating instructions:	?
Mental Workload:	lowered

2. Emotional / Motivational Level

Product Perception:	positive, Safety and Comfort
Product Acceptance:	very high (> 90%)
Willingness to pay:	O 1000$

3. Psycho-Motor-Performance

Controllability in failure state:	?
Reduction in performing skills	not expectable

4. Product Use and Responsibility Level

subjective Responsibility:	minority will partly delegate
"Risk Compensation“:	free mental capacity will be used elsewhere

Lessons Learned..........
The Need for an Integrated Approach

- Overall evaluation on traffic safety:
  some specific accidents may occur but in the end there will be a benefit of safety

- No on-road user experiences with lateral control systems and systems of automatic driving (projects on lateral support are just starting)

- What we need are User Trials with automatic driving and appropriate evaluation concepts

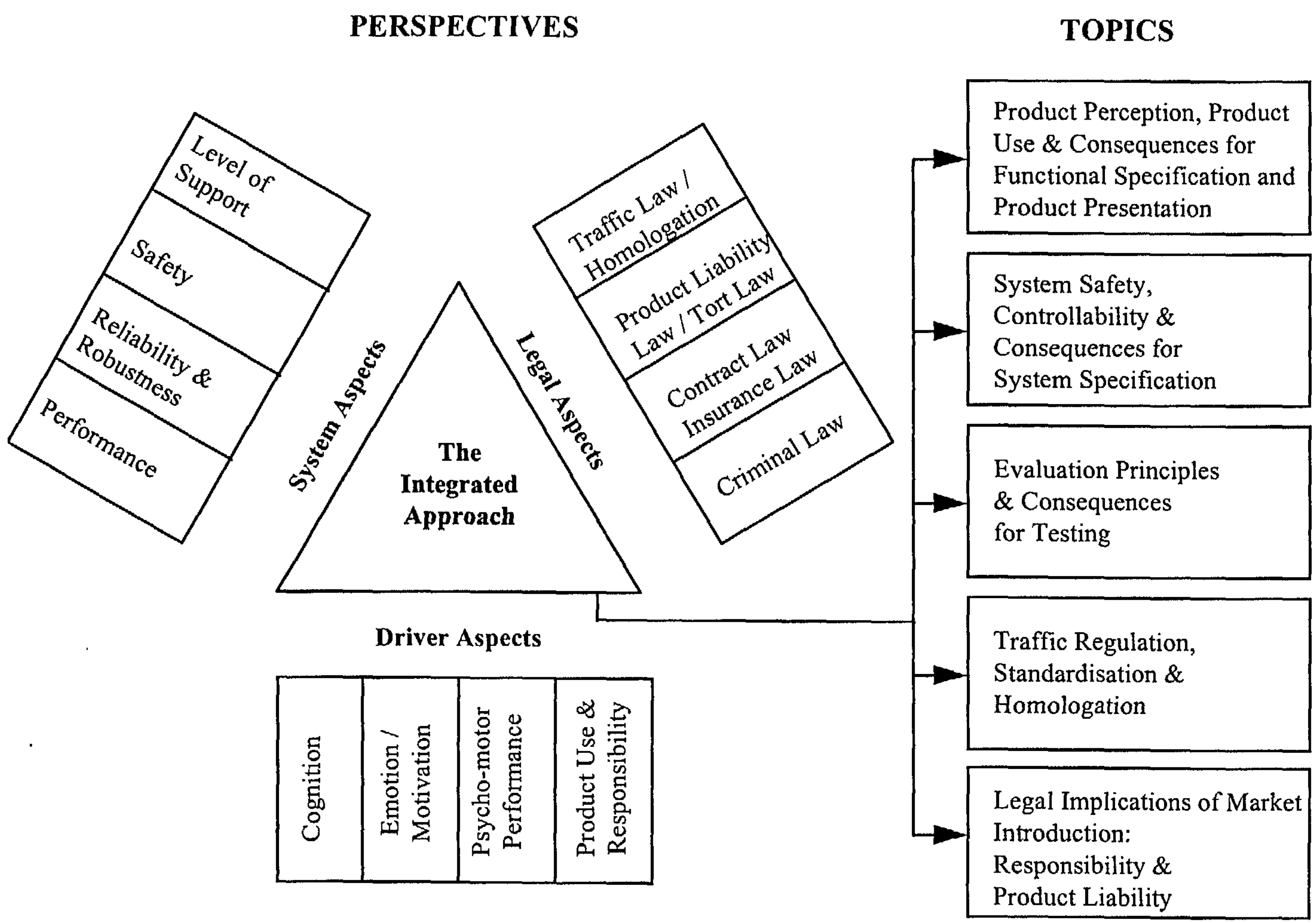
- System development and Market Introduction needs the Integration of Driver, System and Legal Aspects

- An European Contribution:

Legal Aspects Task Force
(AC-ASSIST, Chauffeur, UDC)

RESPONSE
Vehicle Automation -
Driver Responsibility - Provider Liability -
Legal and Institutional Consequences

Lessons Learned..........
Work do be done

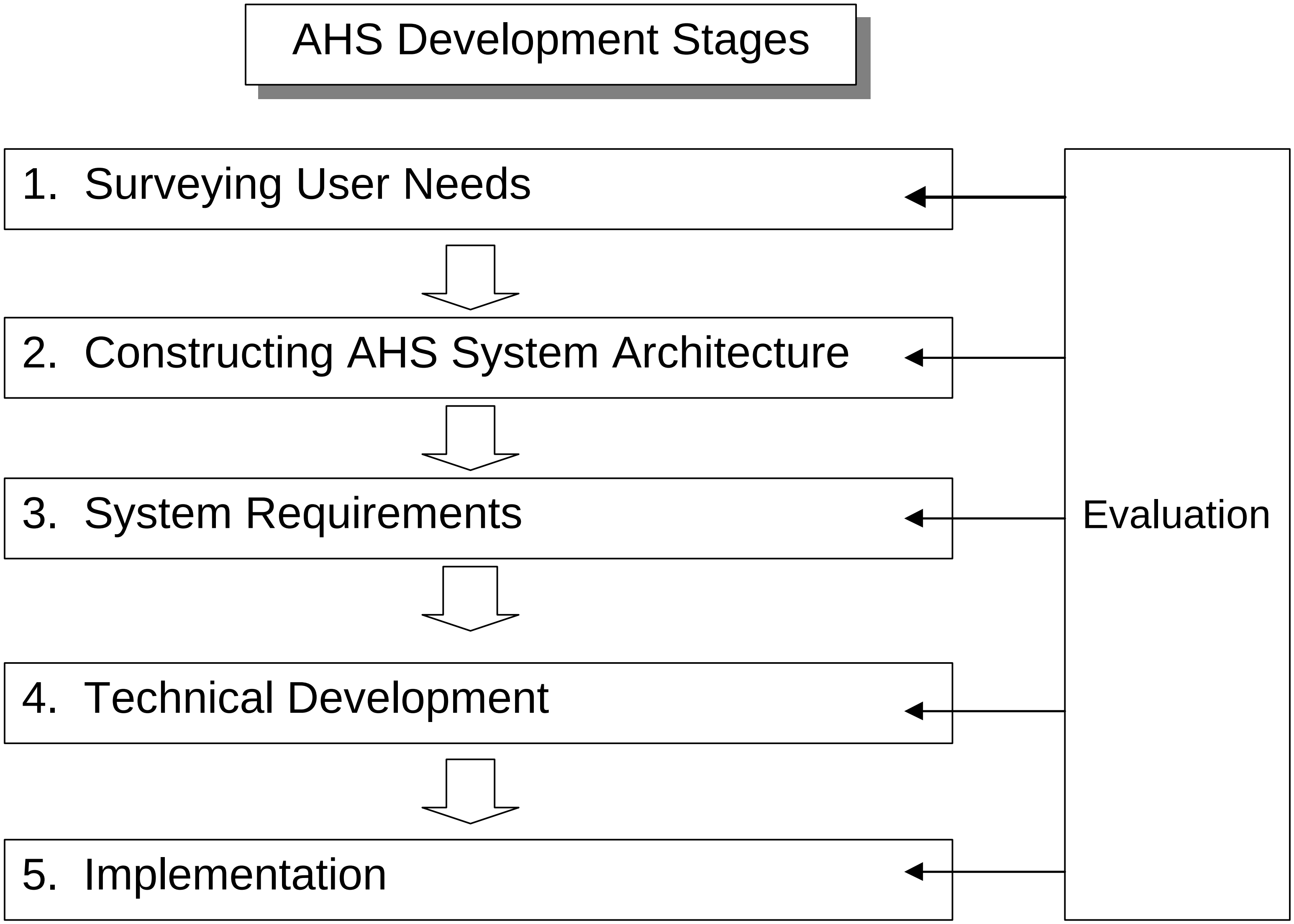


Toward the Realization of AHS

Lessons Learned Panel Session
Aug. 11th, 1997

Ministry of Construction

Nobuyuki Ohtera


AHS Development Stages
1. Surveying User Needs
2. Constructing AHS System Architecture
3. System Requirements
4. Technical Development
5. Implementation
Evaluation

1. Investing User Needs

<Working Items>

- Surveying User Needs
- Define the Service Levels Provided by the system

<Issues>

- Public Acceptance
- Market Opportunity
- Benefit and Cost

2. Constructing System Architecture

<Working Items>

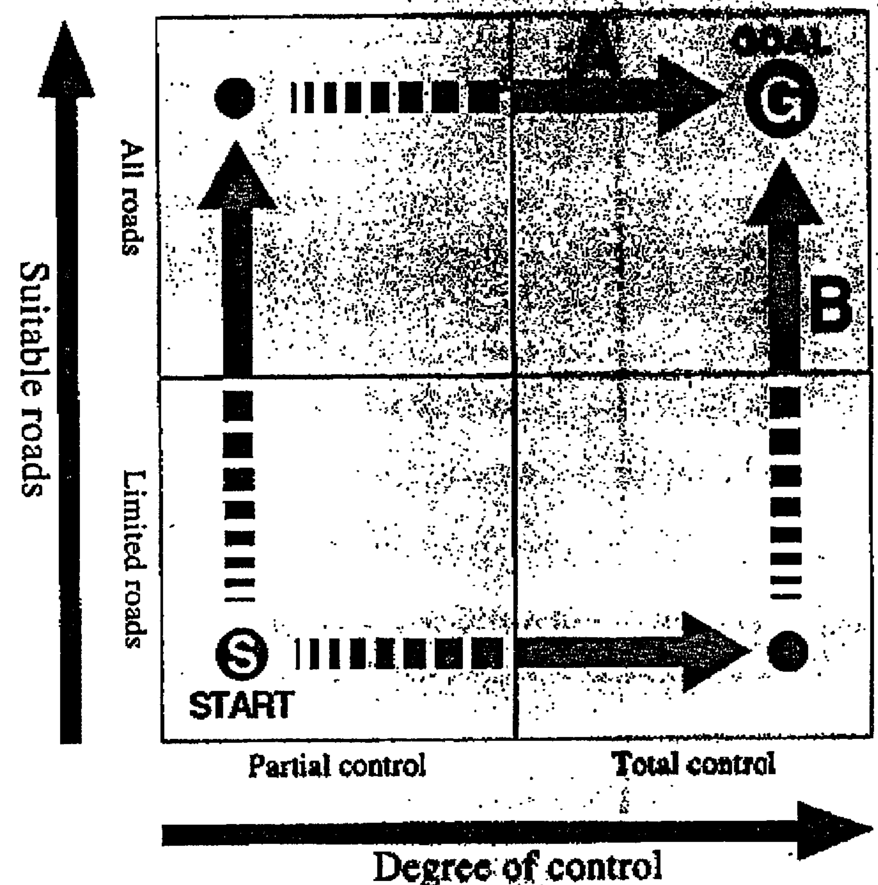
- Concept
- Deployment Scenario
- Constructing System Architecture
  (system Architecture on AHS-I, AHS-c, AHS-a)

<Issues>

- Role Sharing between Human and System
- Role Sharing between Infrastructure Equipment and Vehicle
- Public Acceptance
- Market Opportunity
- Benefit and Cost

Two Processes to achieve fully automated driving

ITS Intelligent Transport Systems



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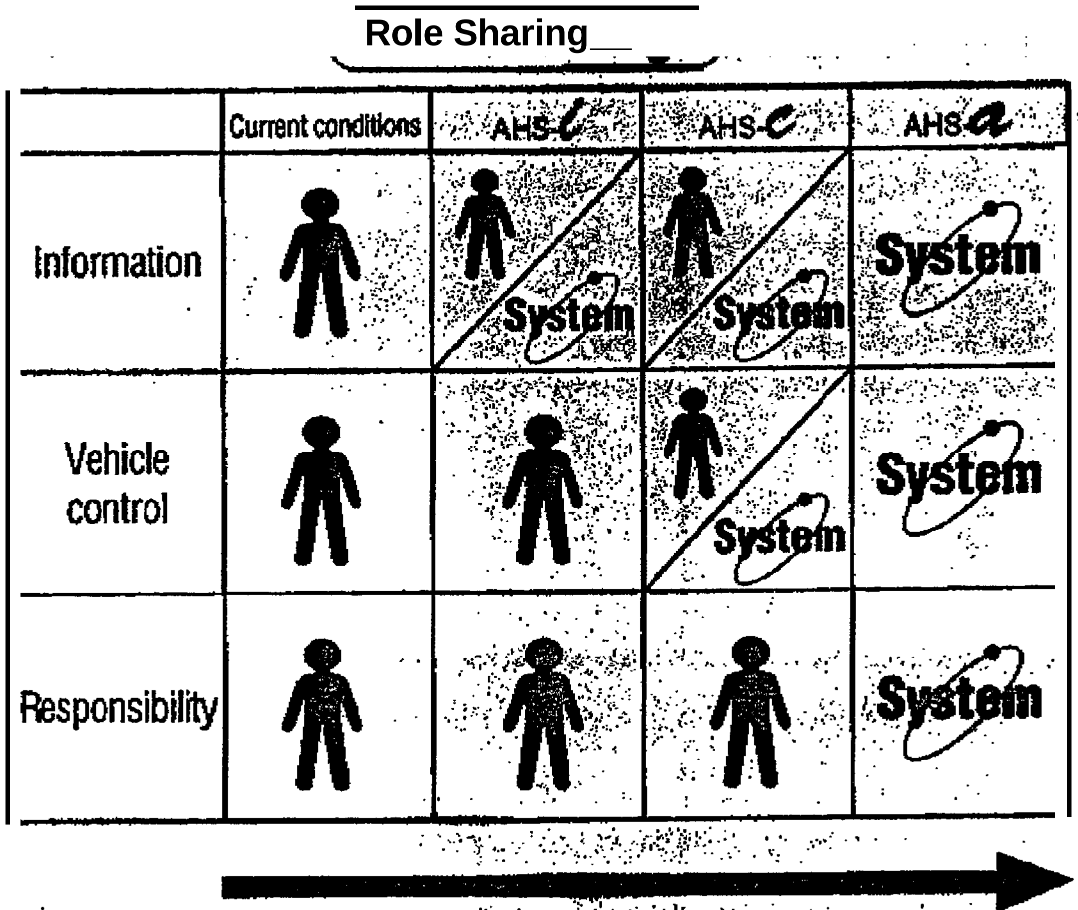
Subsystems of AHS



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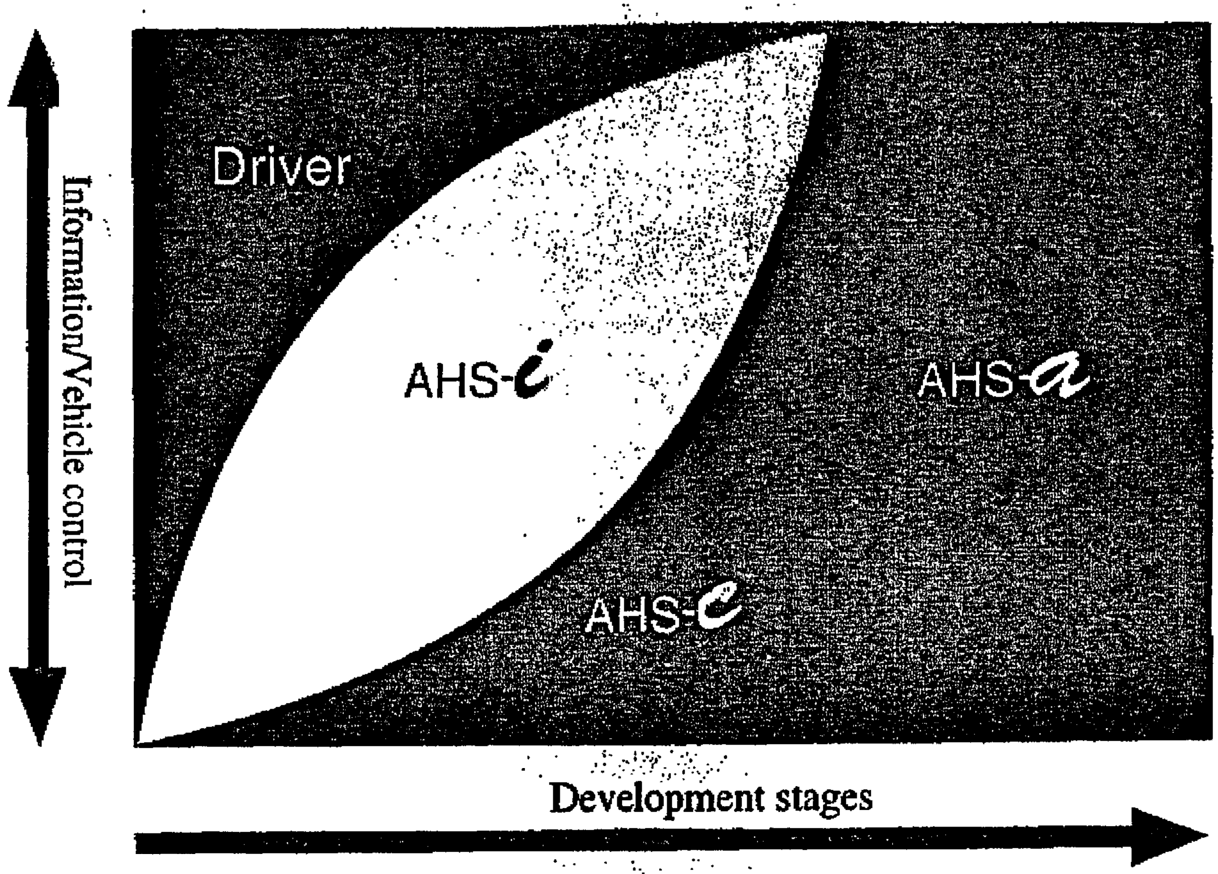
AHS Evolution



3. System Requirement

<Working Items>

- Define Requirements for Various Modules of AHS

<Issues>

- Balance between Function and Cost
- Regal Issues (Ex. Radio Wave Frequency etc.)

4. Technical Development

<Working Items>

- Developing Significant Technical Factors on AHS
  - Sensor
  - Vehicle Control
  - Communication
- System Integration

<Issues>

- Human Machine Interface
- Standardization
- Security
- System Reliability
- Balance between Function and Cost

5. Implementation

<Working Items>

- Infrastructure Module’s Implementation
- Market Penetration

<Issues>

- Implementation and Market Strategy
- Education and Training
- Regal Issues
  (ex. Insurance, Products Liability)

AHS Development Key Factors

A. Standardization

B. Requested Function and Cost

C. Harmonization between
AHS and other ITS Application

→ **Promote International Cooperation and Harmonization**

ITS Activities of Japanese MITI
and
AVCS for Japan

Sadayuki TSUGAWA

Mechanical Engineering Laboratory, MITI

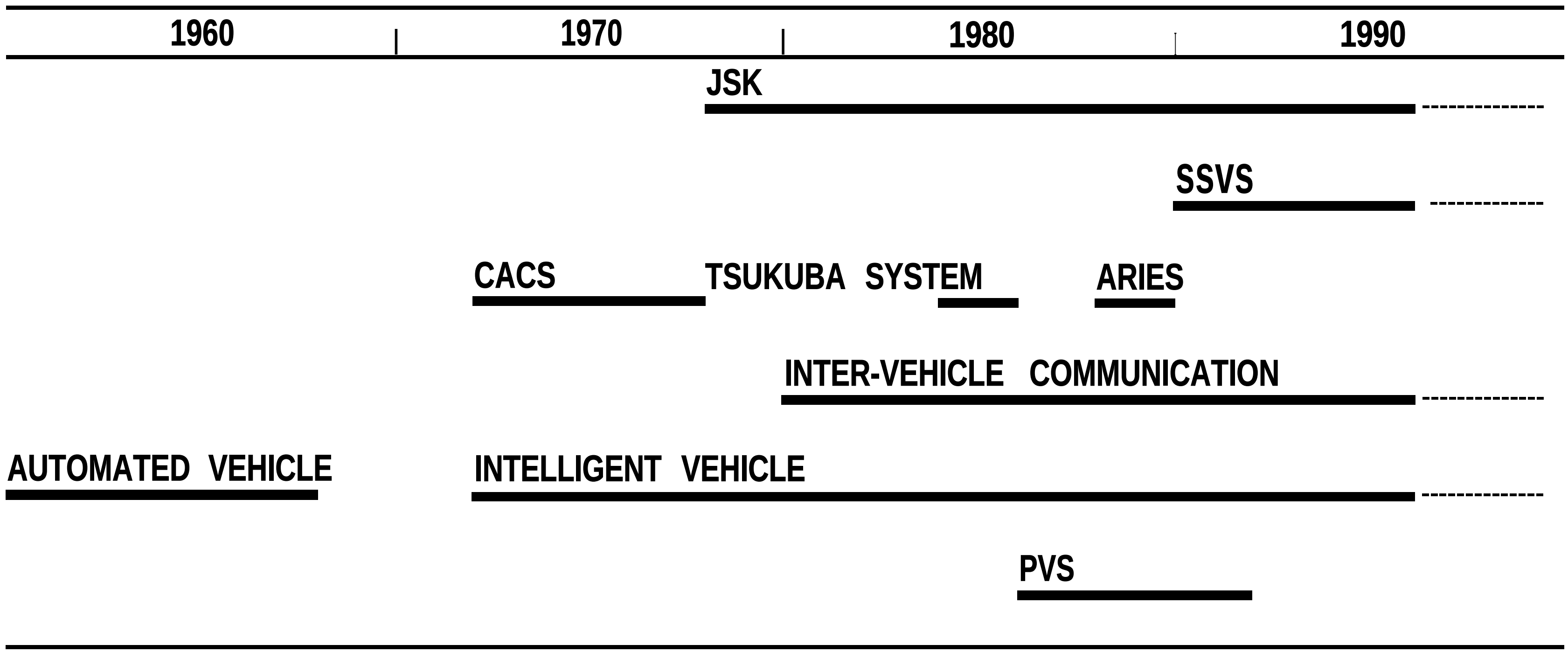
Attachment #11-7-B

ROLES OF MITI

- Research
  - AIST and Research Institutes
  - Large Scale Projects: CACS, EV,...
  - Foundation: JSK
- Standardization
  - Standards Department in AIST

    JIS, ISO/TC204

HISTORY OF ITS IN MITI



- ITS Studies by MITI, MEL, JSK
  - 1990-92, 92-
- Vehicle Oriented AVCS
  - Intelligent Driving System for 20-30 Years from Now
  - Safety, Efficiency, Environment, Aging Society

ITS PROJECTS IN JAPAN

	Vehicle-Oriented	Infrastructure-Oriented
ATMS ATIS		VICS UTMS
AVCS	ASV SSVS	MOC-ITS (ARTS)

AVCS PRODUCTS IN JAPAN

- Drowsiness warning System [1983]
- Inter-Vehicle Gap warning System for Heavy Duty Trucks [late 1980s]
- Adaptive Cruise Control for Passenger Car [1995]

ROAD TRAFFIC IN JAPAN

- Rate of Passenger Cars
  - JPN < USA, GER
- Role of Passenger Cars
  - JPN < USA, GER
- Role of Trucks
  - USA < JPN, GER
- Road per Vehicle
  - JPN < USA, GER

ROAD TRAFFIC SPECIFIC TO JAPAN

- Number of Trucks
- Roadways
  - Highways per Vehicles
  - Width of Roadways
- Pedestrians, Bicycles, Motorcycles
- Fatal Accidents: JPN vs USA
  - [Pedestrians] 27% vs 14%
  - [Passengers] 42% vs 84%

AVCS FOR FUTURE JAPAN

- ITS for Japanese Road Traffic
- Systems Suitable to Japan
  - Automated Driving on Stop/Go
  - Platooning for Heavy Duty Trucks
  - 2D Platooning of Small vehicles
  - Station Car
  - Automated Driving for Busses
- Mobility under Bad Weather

ISSUES

- “Chicken and Egg” Problem
  - Route to Cooperation between Infrastructure and Vehicles

- Needs of ITS Specific to Japan
  - Different Road Traffic from US and Europe

AHSRA

International Workshop/ AHS
August 17-12, 1997

AHS-*i,c,a*

Accident Prevention Infrastructure Technology Development

11/12 Aug, 1997

Susumu Okawa

Advanced Cruise-Assist Highway System Research Association, Japan

Content

1.Traffic Accident in 1995

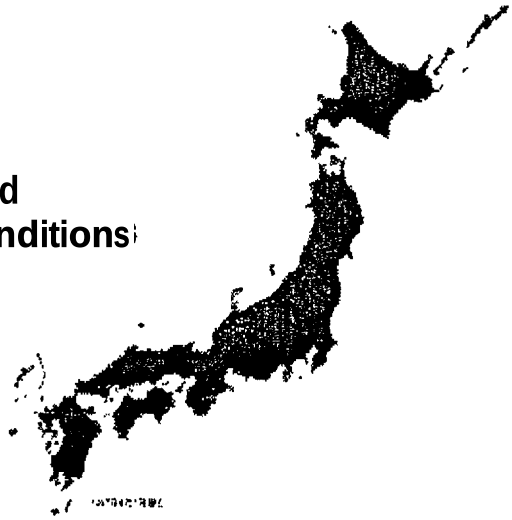
2.Traffic Accident in 2000 and over

3. Accident Prevention
Infrastructure Key Technology

4. Summary

Traffic Accident in 1995

- Mountainous land
  a) winding road
  b) Tunnel and Bridge
  C) Uphill and downhill road
- Rigorous Environmental Conditions
  a) Heavy rain
  b) Heavy snow
  c) Dense fog

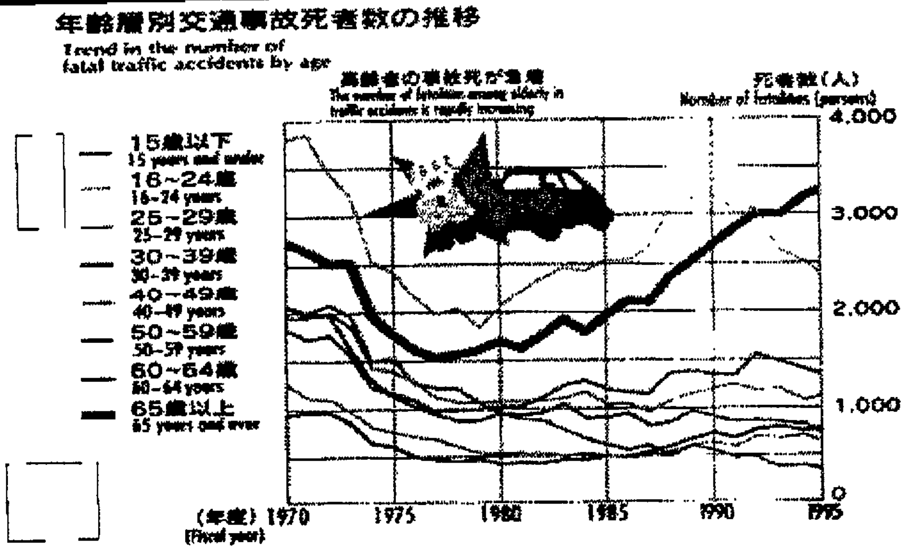


	Highway	Common Road	remarks
Fatal Accident Number	320	10,359	10,679
Total Accident Number	6,803	754,986	
Road length	5,677km	1,136,631km	
Fatal Accident Number/100km	5.6	0.91	5.6/0.91=6.2
Total Accident Number/100km	120	66	120/66=1.8

The road closing and traffic congestion by fatal accident in Highway give serious adverse effect to Lean Production System in Japan.

d

Number of Total Traffic Accidents by Age - 1995



出典：トラフィックグリーンペーパー 1996年（全日本交通安全協会）
Source: 1996 Traffic Green Paper (Japan Traffic Safety Association)

Number of fatalities (persons)

	Vehicle (D + P)	Motor - cycle (D + P)	Bicycle	Pedestrian	Etc.	Total
All Ages	4550	1991	1121	2987	30	10679
60~64 years	308	101	92	285	3	788
65 years and over	592	397	572	1658	21	3240

The number of fatalities among elderly people in traffic accidents is rapidly increasing year by year.

Study of the Causes of Fatal Traffic Accidents - 1995

1. Safety is the highest priority : encourage other benefits (e.g., efficiency, comfort).

2. Infrastructure R & D with hum factors considerations is the most important,

   More than 90% of the fatal traffic accidents is human-related causes.

57%	:	Inattention, distraction and delayed recognition
18%	:	Misjudgment of imminent traffic situation
14%	:	Inadequate handling
9%	:	Poor driving ability of driver

3. Elderly people's error is the predominant cause of fatal traffic accident.

d

AHSRA

Content

1. Traffic Accident in 1995

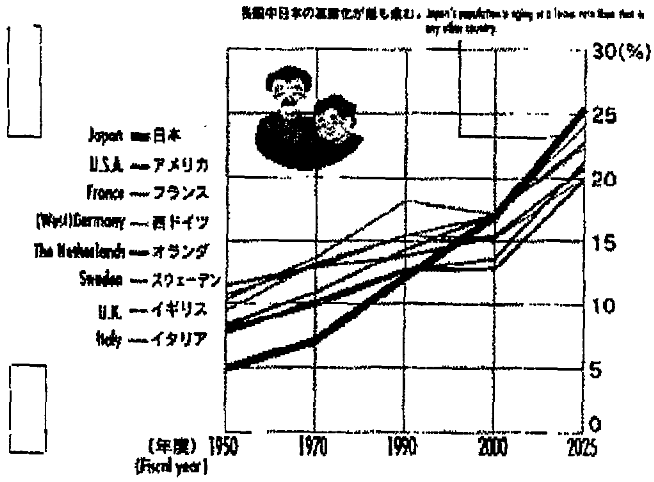
2. Traffic Accident in 2000 and over

3. Accident Prevention Infrastructure Key Technology

4. Summary

The Aging of the Population of Japan

65歳以上人口割合の国際比較 International comparison of the percentage of the population accounted for by persons aged 65 and over



出典：日本の将来推計人口（厚生省人口問題研究所）
UN-Population Projections As Assessed in 1990
Source: Estimates of Japan's Future Population (Institute of Population Problems, Ministry of Health and Welfare)
UN Population Projections As Assessed in 1990 (The United Nations)

Driver License Holder Estimation

(Million persons)

	1995	2000	2005	2010
60～64 years	3.81	4.8	6.2	8.6
65 years and over	4.78	8.0	11.5	15.0

AHSRA

Traffic Accident in 2000 and over

Characteristics of Elderly Driver

1. A decline in eyesight far stationary and moving objects.
2. Multi-task(percept ion-judgement-act ion) tends to induce delayed and poor driving.
   - Driving speed is lower.
   - Vehicle headway is larger.
   - Delayed acceleration at start.
   - Delayed braking.
   - Poor right furn at the intersection.
   - Poor lane keeping.
     - → Apt to deviate to left-ward in the lane.
   - Poor maneuvering in curved mad.
   - Poor merging.

⇨ • Elderly-driver involved in traffic accident will be predominant.

d

AHSRA

Content

1. Traffic Accident in 1995

2. Traffic Accident in 2000 and over

3. Accident Prevention
   Infrastructure Key Technology

4. Summary

Infrastructure Key Technology Development

1 Cooperative infrastructure with human factots conditions is the first priority in R & D

2. Three Cooperative infrastructure assistances are essential for prevention of traffic accident in 2000 and over.

AHS-*i* Information Provision and Warnings

AHS-*c* Control assistance

AHS-*a* Automatd cruise

d

AHSRA

Service Range of *i,c,a*

AHS-*i* **Information provision and Warning**

e.g.,

- Provision of Driving and Road Conditions Information
- Blind Curve Obstacle Warning
- Forward Obstacle Warning
- Short Range Obstacle Warning
- Traffic Impediment warning
- Lognitudinal Collision Warning
- Rear-end Col lision Warning
- Lateral Collision Warning
- Over speed Warning

AHS-*c* **Control Assistance and Intervention**

e.g.,

- Lane departure Prevention Steering Control
- Longitudinal Collision Prevention Braking
- Rear-end Collision Prevention Braking
- Vehicle Headway Keeping Control

AHS-*a* **Automated Cruise Assistance**

e.g.,

- Automated Vehicle Headway Distance Keeping control in traffic congestion
- Automated Cruise in rigouous weather conditions

AHSRA

Accident Prevention Infrastructure Key Technology in 2000 and over

AHS-*a* (Automated Cruise)

AHS-*c* (Control)

AHS-*i* (Information)

3. Accident prevention key Technology

1 Road Surface Condition Detection Technology

2 Road Surface Obstacle Detection Technology

3 Vehicle Monitoring & Behavior Detection Technology

4 Vehicle Guide & Control Technology

5 Vehicle-Posit ion Recognition & Lane Marker Technology

6 Road-Vehicle Communication Technology

&I d

Evolution of key Technology

4. Key technology has 3 levels of increasing capabilities to meet AHS-i c, 8 service range.

Example: Road Surface Condi t ion detect ion Technology

Three levels

Level 1 : Detection

Level 2 : Detection and Predict ion

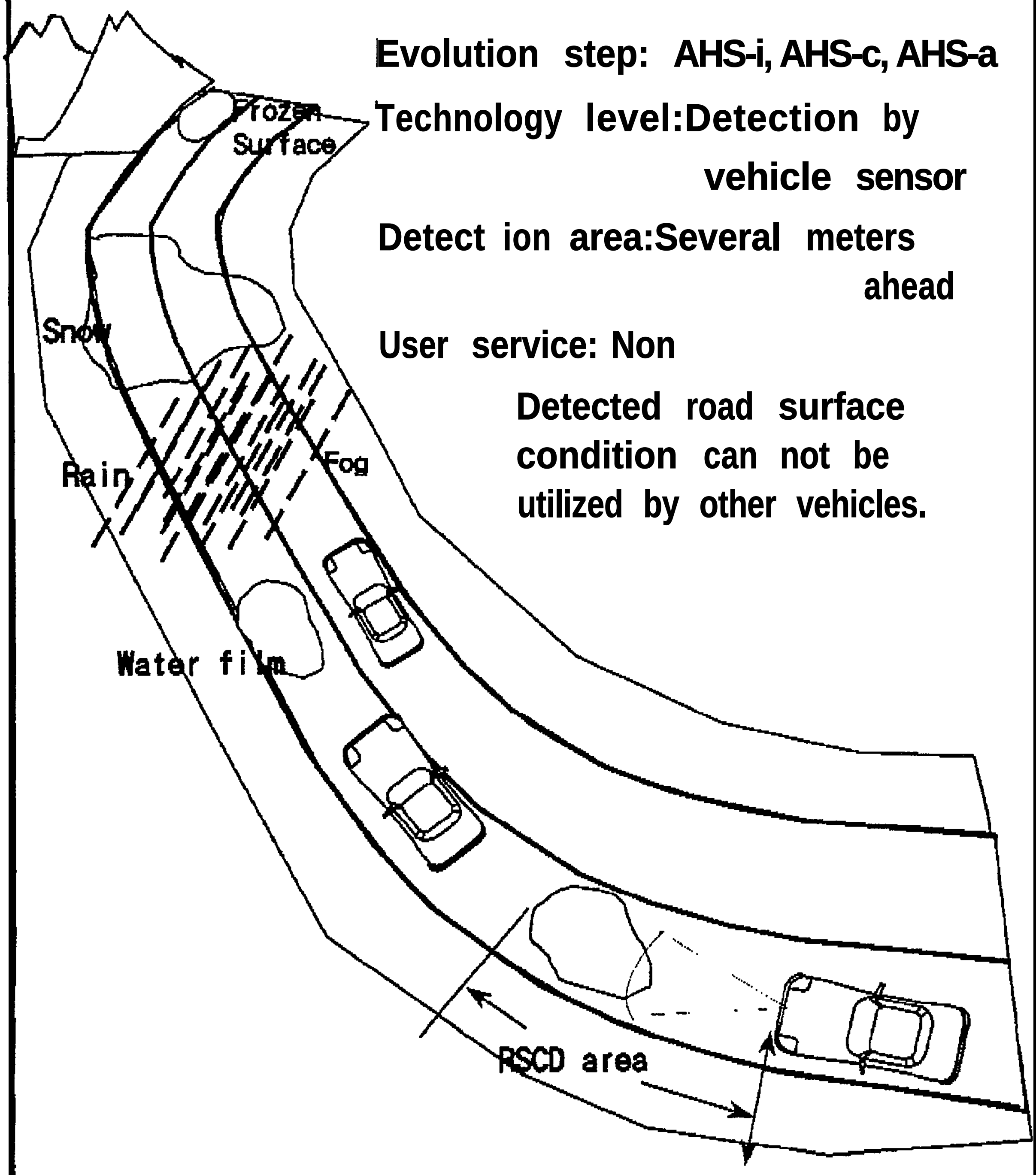
Level 3 : Detection, Prediction and Estimation

Data Processing Algorism
e.g. Detect ion
Predict ion
estimation

Road-vehicle Communicat ion

d

Road Surface Condition Detection (RSCD) Technology by Autonomous Vehicle



Evolution step: AHS-i, AHS-c, AHS-a

Technology level: Detection by vehicle sensor

Detect ion area: Several meters ahead

User service: Non

Detected road surface condition can not be utilized by other vehicles.

d

Road Surface Condition Detection (RSCD) Technology - LEVEL 1

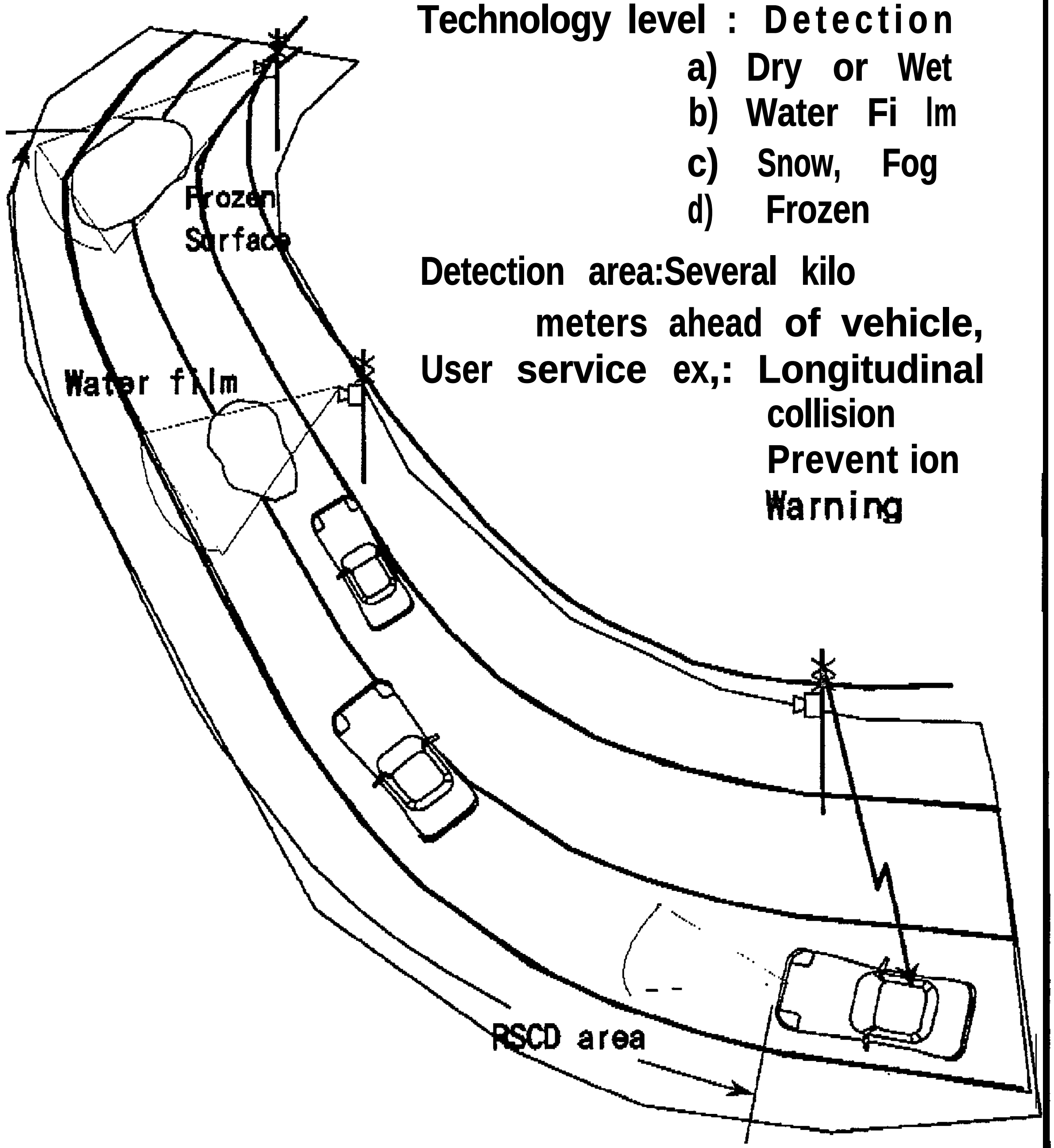
Evolution step: AHS-i

Technology level : Detection

a) Dry or Wet
b) Water Film
c) Snow, Fog
d) Frozen

Detection area: Several kilometers ahead of vehicle,

User service ex,: Longitudinal collision Prevention Warning



Road Surface Condition Detection (RSCD) Technology - LEVEL 2

AHSRA

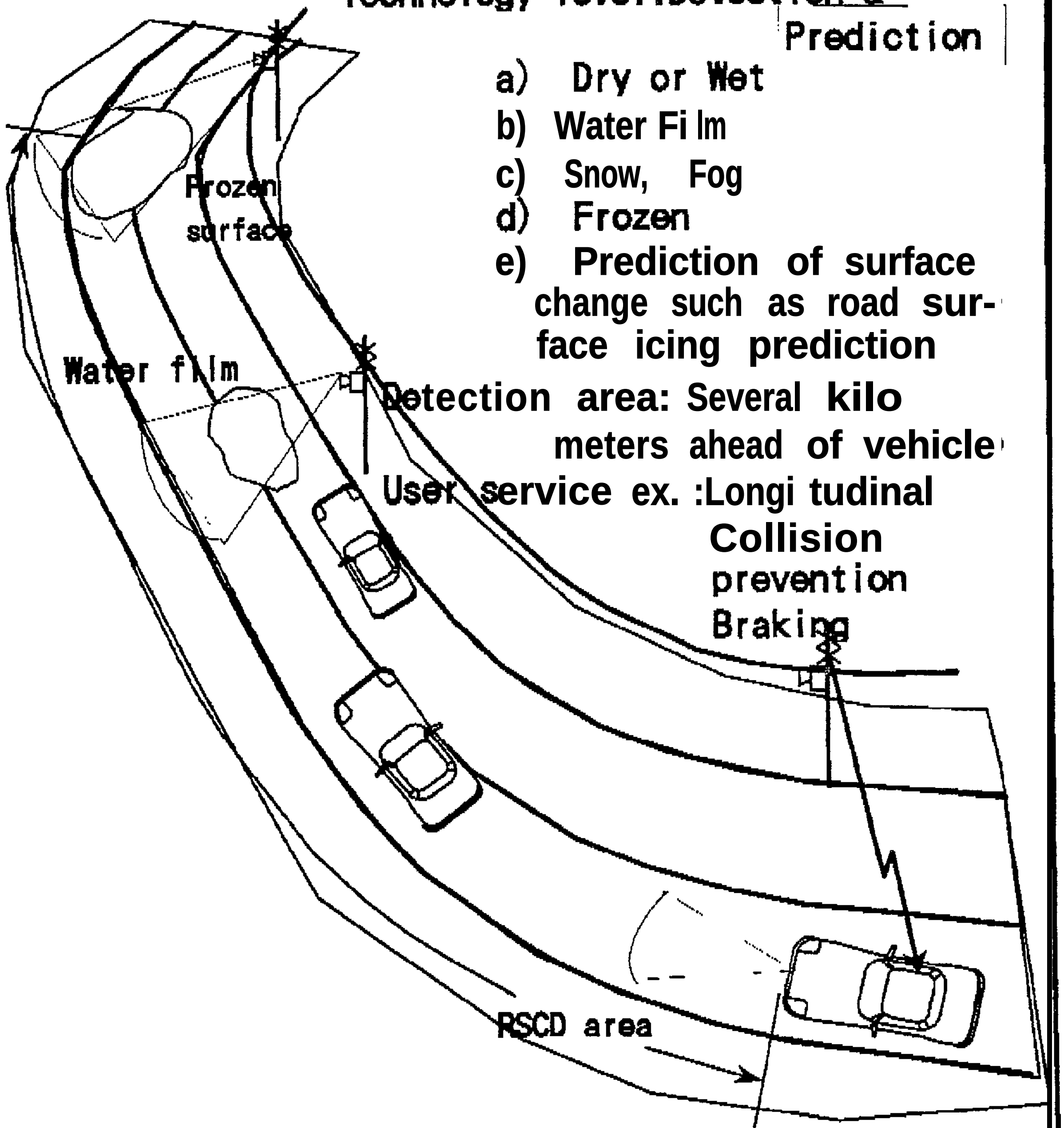
Evolution step: AHS-i, AHS-c

Technology level: Detection & Prediction

a) Dry or Wet
b) Water Film
c) Snow, Fog
d) Frozen
e) Prediction of surface change such as road surface icing prediction

Detection area: Several kilometers ahead of vehicle

User service ex.: Longitudinal Collision prevention Braking



d

出典:AHSｼﾝﾎﾟｼﾞｳﾑ

Road Surface Condition Detection (RSCD) Technology - LEVEL 3

Evolution step: AHSi,AHSc, AHS-a

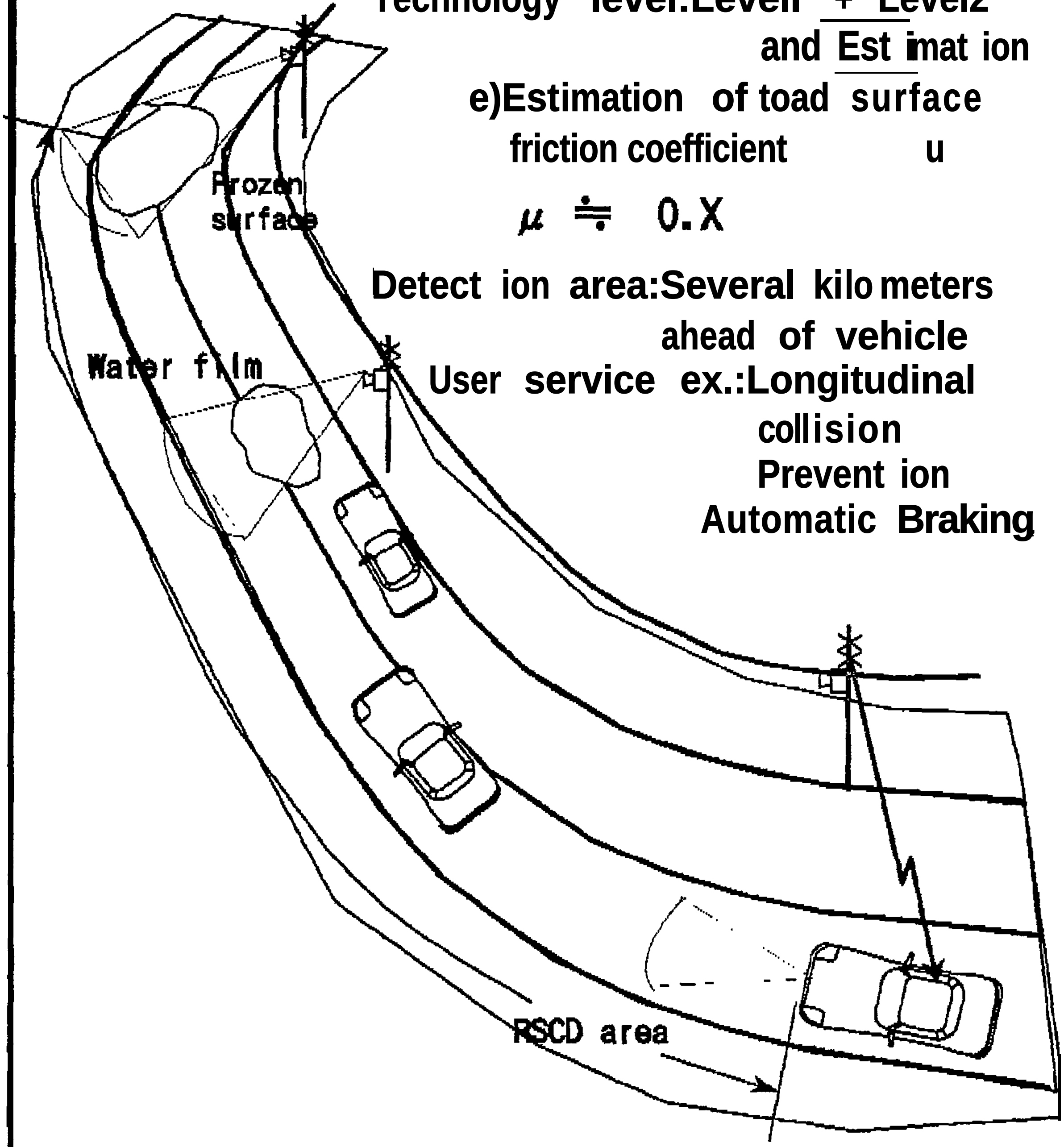
Technology level:Levell + Level2 and Est imat ion

e)Estimation of toad surface friction coefficient u

$\mu \fallingdotseq 0.X$

Detect ion area:Several kilo meters ahead of vehicle

User service ex.:Longitudinal collision Prevent ion Automatic Braking



81 d

Content

1. Traffic Accident in 1995

2. Traffic Accident in 2000 and over

3. Accident Prevention
   Infrastructure Key Technology

4. Summary

Summary

1. Human error, especially elderly driver error prevention is the most important.

2, Cooperative Infrastructure Assistance is essential for prevention of traffic accident in 2000 and over.

3. Infrastructure key Technology has 3 levels of increasing capabilities for AHS-i,c,a service range.

4. International cooperative items
   a. Human ability investigation, psychologically and physically
   b. Elderly driver-vehicle interfaces

d

Notes from Global Rollout session
Job J. Klijnhout
Wrap-up and discussion.
In 1992 Prometheus expected the introduction of AICC by the year 1997.
Can we predict what function or application will be on the market in the near future, say between now and 2002.

AICC is now on the market .
Stop and go AICC: opinion varies from before 2002 to after 2005
Dedicated lanes for busses (Tokyo) or trucks with a container (Combiroad) 1998.
Warning against run-off-the-road, lanekeeping assistance for trucks 1999, automated versions for trucks 2001.
The version for cars will be part of a package including AICC.
Impaired driver systems, drowsiness control (warning) 2000-2002
AICC combined with anticollision for cars 2002-2004
Snowplow automation 2002
Speed and other information from the roadside to the vehicle 2000
Stationcars level 0 (not really “AHS”) 1997 (Paris), level 1 automation 2002
Specific services for the elderly like:

selection of safe routes (less left turn, no complicated intersections) ?
warning against lateral collisions ?

Note the problems of the elderly drivers require automatic vehicle guidance support asap.

Panel of Industrialists

First International Workshop on Vehicle-Highway Automation
San Diego,CA, August 11 - 12, 1997

Purpose of Session:

- Present and discuss RTD and deployment activities in US, Japan and Europe considering various industrial and business aspects.

- Conclude on future steps and potential collaboration.

97-08-07

Attachment #12-1-A

Schedule of Session

- Presentation by each Panelist.
  Short questions and answers.

- ITS - AHS discussion Panel - Audiance.
  “Lively” participation by audiance expected.

- Conclusions.

EUCAR

European Council for Automotive R & D

Ulf Palmquist
Volvo Continental / Volvo TD
Ass. Gen. Secretary EUCAR

97-06-23

Objectives of EUCAR

- Collaborative Research and Technological Development within the Automotive Sector

- Formulation and Communication of future needs

- Speaking partner towards the EU Commission and National Bodies

Some History and Facts

- EUCAR started 1994
  (replaced Joint Research Committee, JRC)
- Members;

BMW/Rover	Daimler-Benz	Fiat
Ford	Opel	Porsche
PSA	Renault	Volkswagen
Volvo		

- Future needs and actions described in the MASTERPLAN of EUCAR

9 Thematic Groups

A: Materials, Structures and Related Processes

B: Engines, Fuels and Exhaust Treatment

C: Manufacturing Processes and Organisation

D: Electric/Hybrid Vehicles and Components

E: Human-Vehicle Interaction

F: Vehicle Development Methods and Processes

G: Technologies for Control Systems

H: Road Traffic Systems and Management

R: Recycling

EUCAR Projects (some) of relevance to **ITS & AHS-a**

System oriented projects;

Chauffeur: Semi-autonomous operation of trucks (electronic tow bar).

Urban Drive Control: Adaptive cruise control, enhanced with road side communication for urban traffic.

AC-ASSIST: Autonomous collision avoidance system based on computer vision and radar.

HMI related projects: ....

EUCAR Projects of relevance to ITS & AHS-*a* (cont.) .

<u>Technology oriented projects;</u>

AWARE & OLMO:	Radar resp. Lidar for collsion warning and avoidance.
X-by-Wire:	Methods and systems for safety related electronics and communication internal the vehicle.
VMBD:	Diagnosis (on and off board) of vehicle systems.

National Activities, (some examples)

- MARTA, France; Road Side Communication (5.8 GHz) on Motorways.
- RTA, UK; Road and Traffic Information using 5.8 GHz link.
- MOTIV, Germany; Continuation in some Prometheus areas. Legal considerations.
- **COMBI-ROAD,** Holland; Special roads for fully autonomous vehicles moving containers from Rotterdam harbour.

European Projects under formation

- RESPONSE; Legal and Liability issues of assisting and automated vehicle systems.

- "AHS-a in Europe"; Technology development. Deployment strategy. Collaboration with US and Japan.

RTD (Research) and Technical Development) / AHS-*a* activities in Europe: Conclusions

- A number of fragmented AHS-a related activities. Not necessarily complete coverage, nor coordinated towards AHS-a.

- Need to structure and focuse the RTD, initiate feasibility and cost/benefit investigations and to develop deployment plans.

Industrial & Commercial Perspective (Automotive Sector) of AHS-***a***

- Today AHS-a is beyond the horizon of the product planners (it is mainly an activity within the research departments).

- Legal & Liability issues unclear and therefore a risk factor.

- Cost / Benefit of user ?
  Who is to pay ? Who will pay ?

Industrial & Commercial Perspective (Automotive Sector) of AHS-*a* (cont.)

- Deployment: Coordinated actions and investments required by many actors (suppliers, auto manufacturers, road operators, service providers, . ..) for sucessful deployment.

- Evolution towards AHS-*a*, no revolution.

- " We "buy" AHS-*a* when AHS-*a* can be sold ! " may be the present attitude by the investors.

Panel of Industrialists

First International Workshop on Vehicle-Highway Automation
San Diego,CA, August 11 - 12,1997

Purpose of Session:

- Present and discuss RTD and deployment activities in US, Japan and Europe considering various industrial and business aspects.

- Conclude on future steps and potential collaboration.

J.C. PERKOWSKI

Attachment #12-1-B

Remarks -- AHS "Industry" Panel -- 8/12/97

"International Meeting"

---

1. Teaming Relationships : Critical Issues
   - Combine existing technology in innovative ways for construction R&D, as much or more so than creating new technology
   - Consortium versus joint venture pros & cons
     (especially need for consensus-building, example of helpful nature of Jim Rillings on NAHSC)
   - Private-owned vs. public-owned
     (examples of BOT, tolls, expectations of financial community)
   - Evolutionary versus revolutionary deployment :
     testing/demo/prototype programs must each be managed separatel

2. Key Aspects of Project Management
   - Manage the cost-sharing
   - Minimum disruption to schedule of existing operations

3. Process of Constructibility Assessment
   - Cost-estimation : crucial to constructibility
   - Subcontract management
   - procurement

4. Technology examples for infrastructure
   - Automation/placement of barriers on dedicated lanes
   - Special materials for pavement wear on lanes where automation may result in otherwise excessive wear
   - Infrastructure-mounted obstacle detection devices
   - Roadway geometry data as input to simulation studies
   - Part of the "market package" effort : infrastructure "building blocks"

Expectations for AHS
by
Computer and Communication Industries

1997. 8. 12

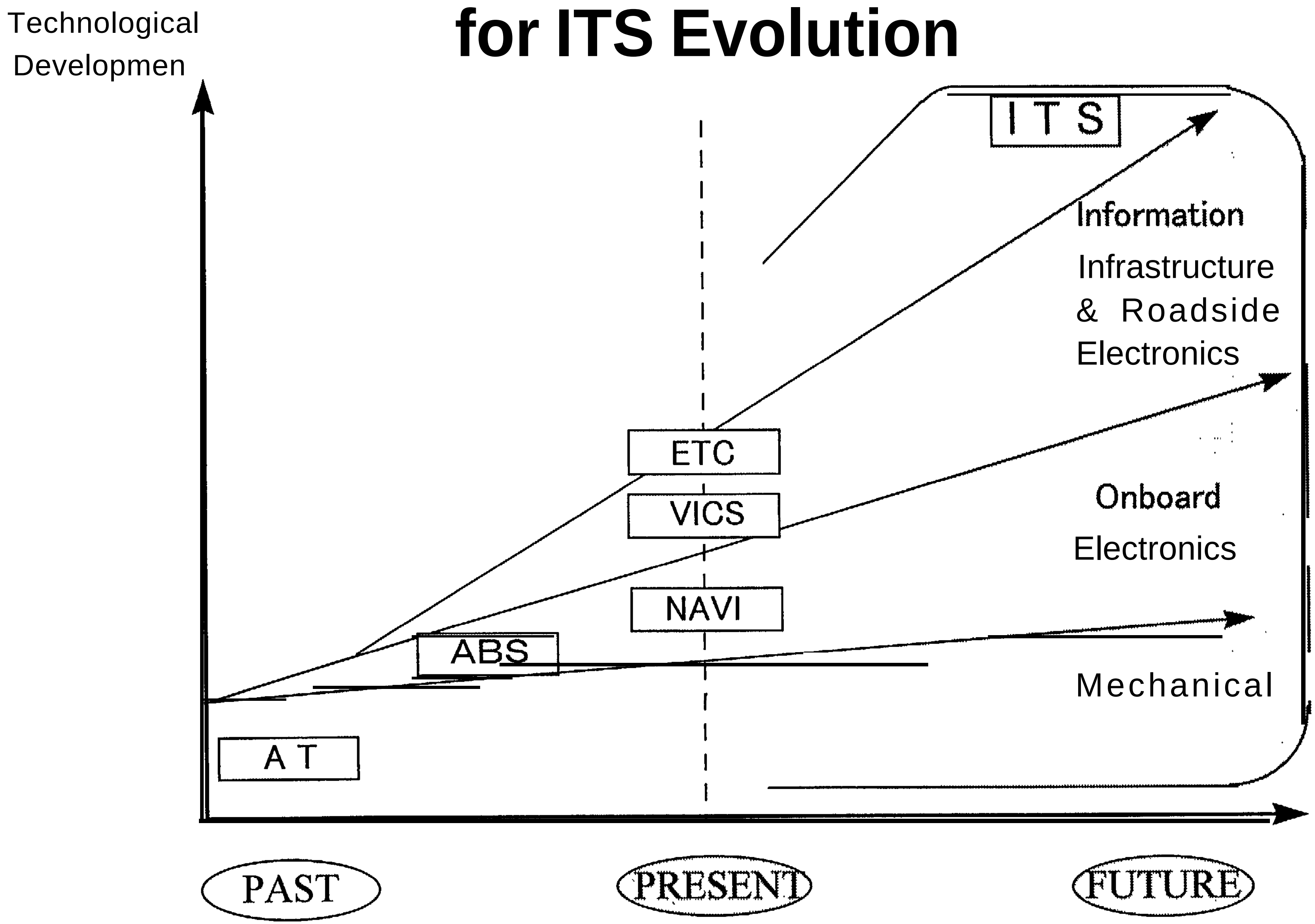
Toshitake Noguchi

AHSRA Task Force

Attachment #12-1-D

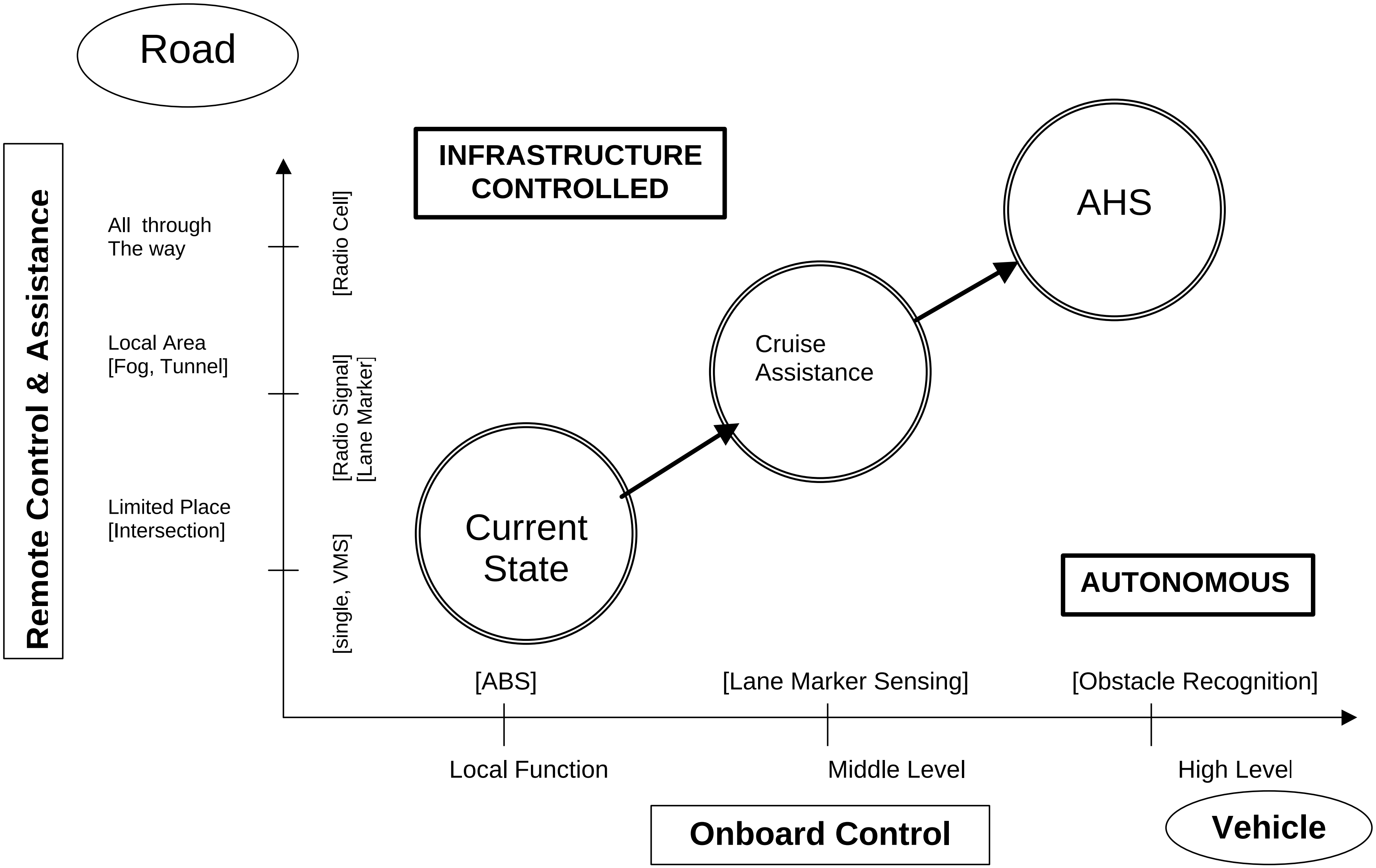
CONTENTS

Development of Technologies for ITS Evolution



CONTENTS

Development of AHS



CONTENTS

1. How have C&C industries been participating?
   (1) Development of technologies
   (2) Participants in AHSRA

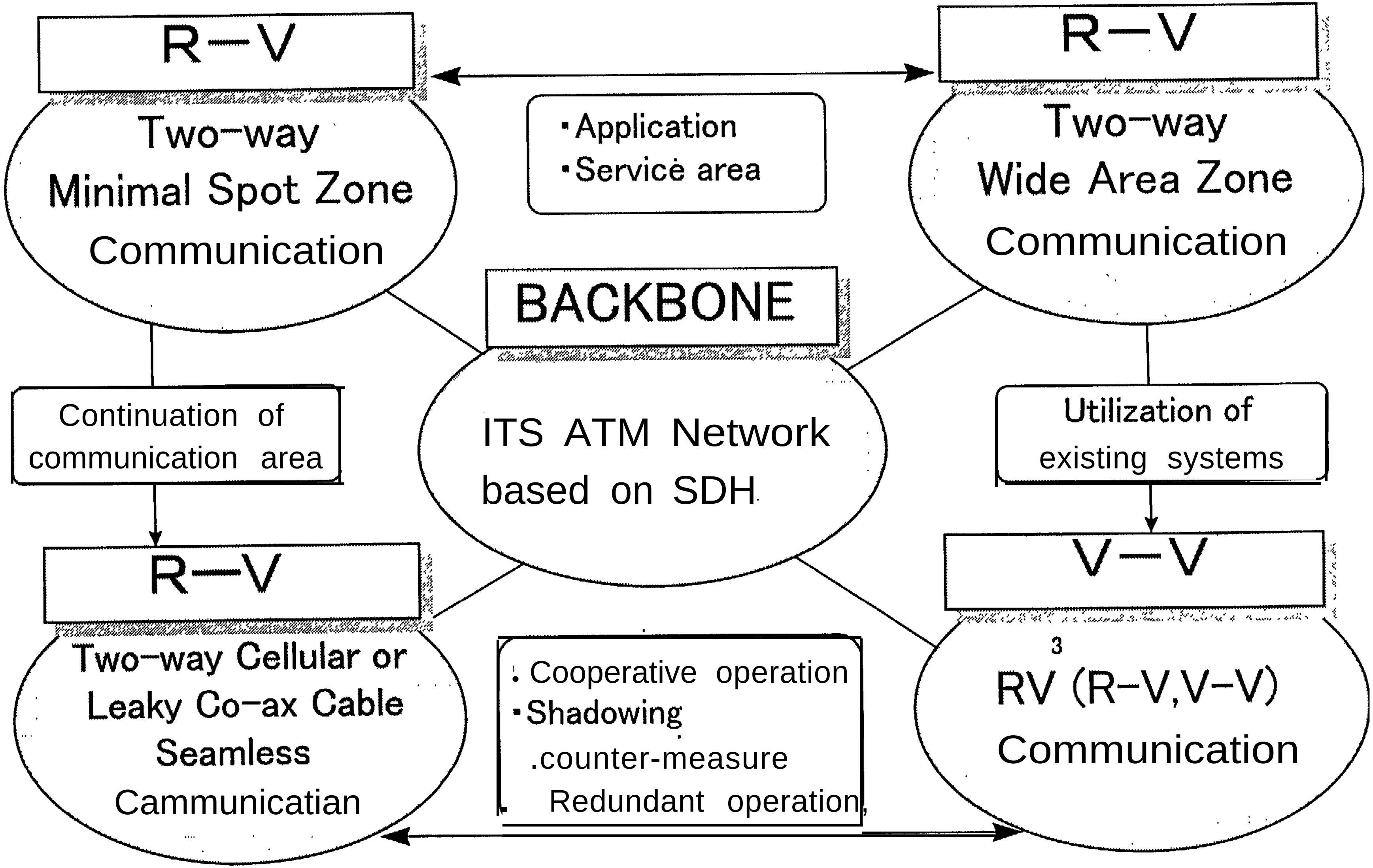
2. How have auto and C&C manufacturers been collaborating?

3. What are tasks for C&C manufacturers?
   (1) Communication network systems
   (2) Control network systems
   (3) Road network systems

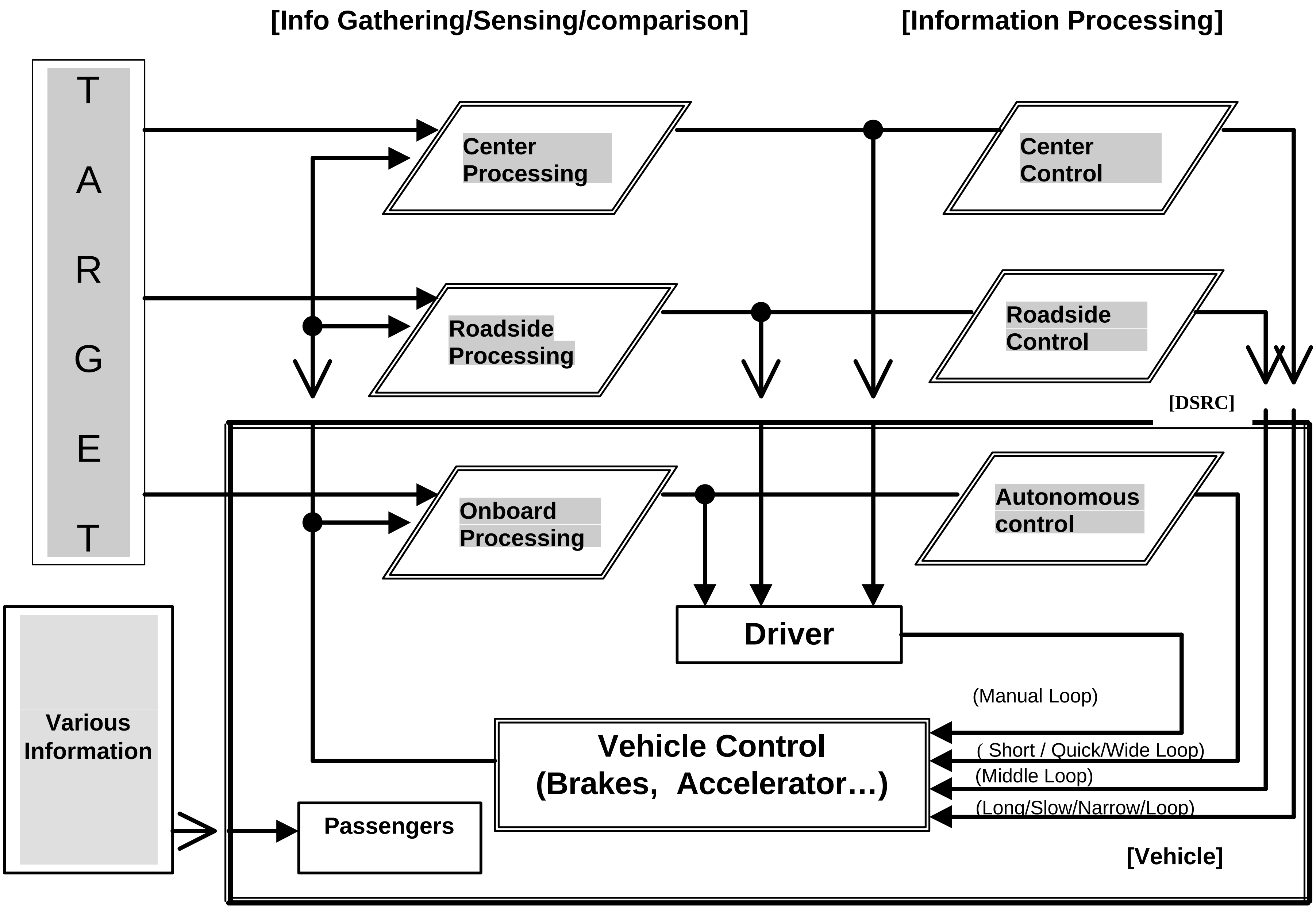
4. What businesses are there for C&C industries?
   (1) Relationship between ITS & NII
   (2) AHS business
   (3) Spin – off business

5. What are the roles of the private sector?

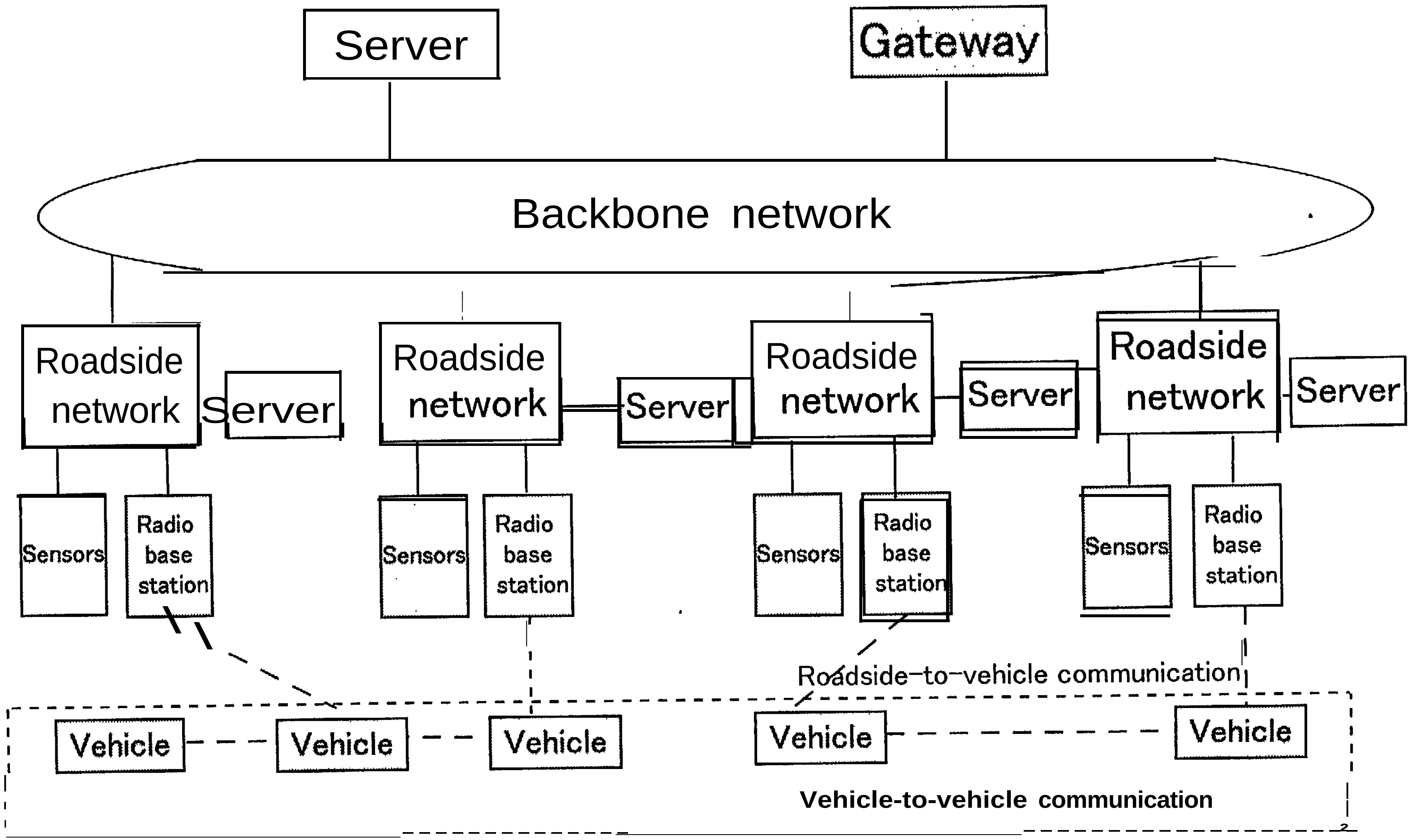
Configuration of Communication Infkastructure towards AHS Realization



Control Configuration of AHS

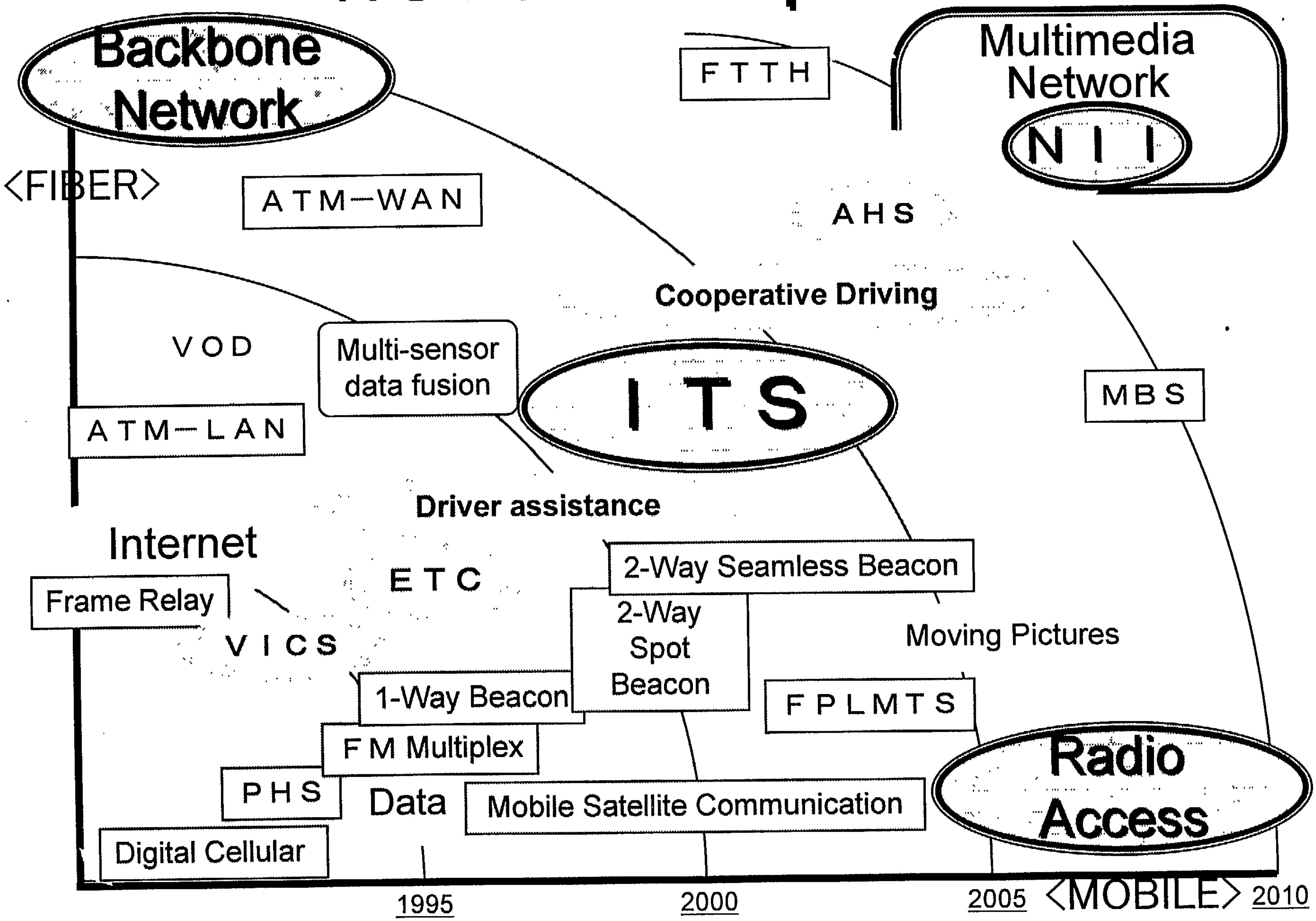


Configuration of ITS Information and-Communication Network

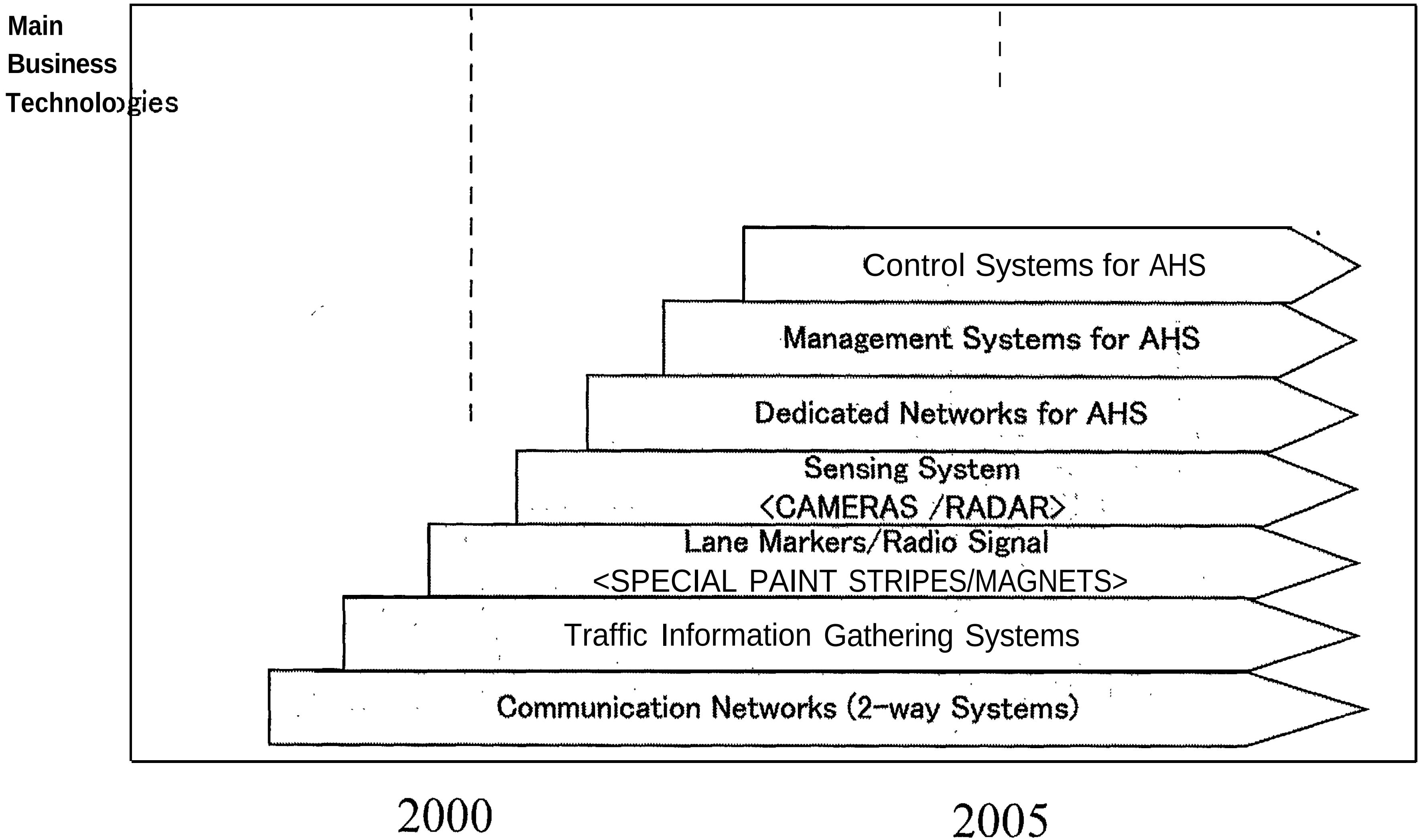


CONTENTS

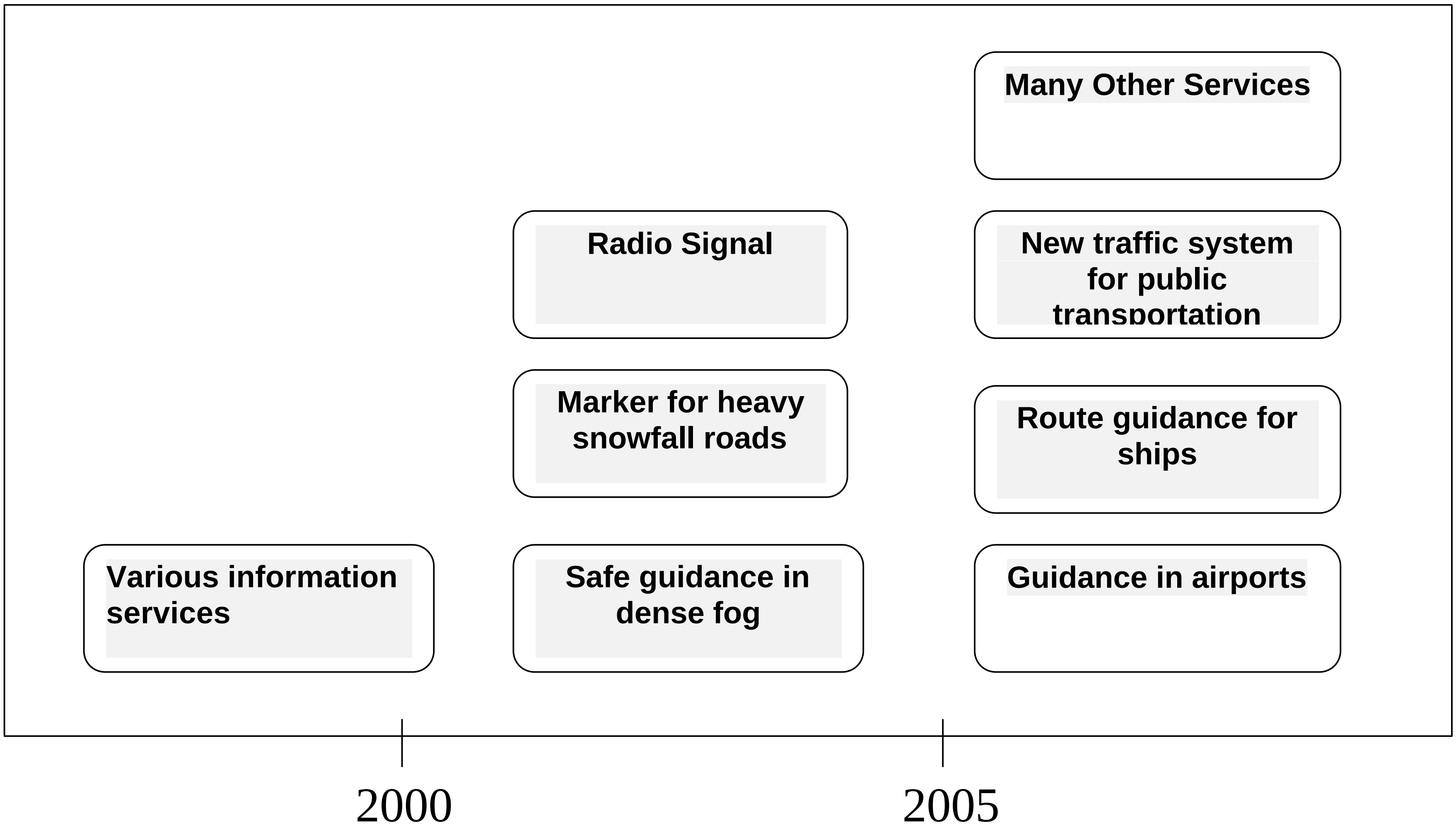
ITS Relationship to NII



Infrastructure Business for AHS



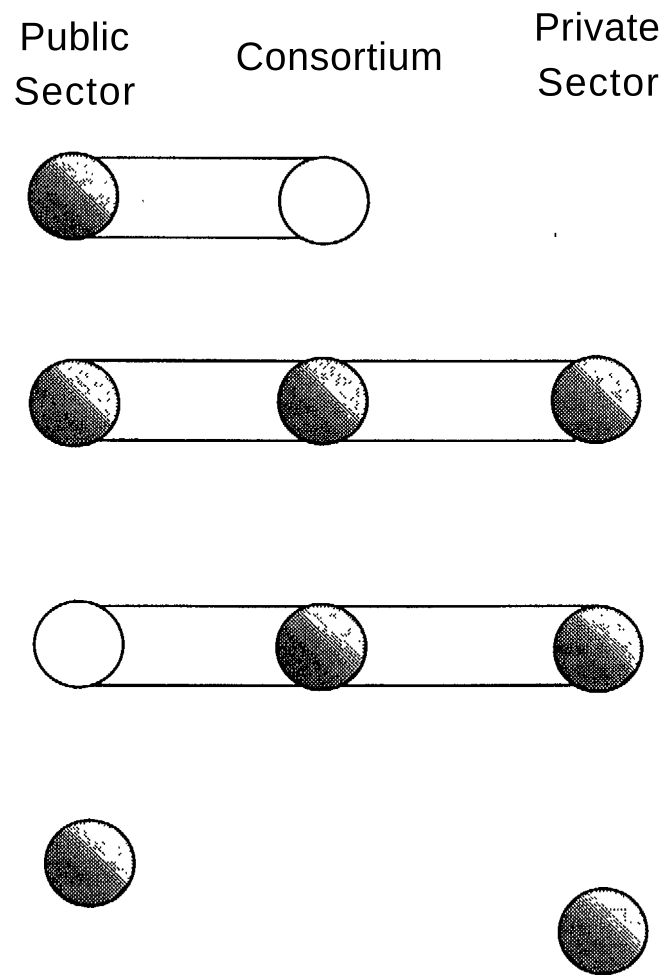
Main Spin-off Technologies



CONTENTS

Roles of Private Sector for Development of AHS

1. Institutional /Legislative Issues
2. Standardization (ISO,ITU-R ,etc)
3. Technological Development
4. Investment /Deployment
   (Infrastructure)
   (Onboard)



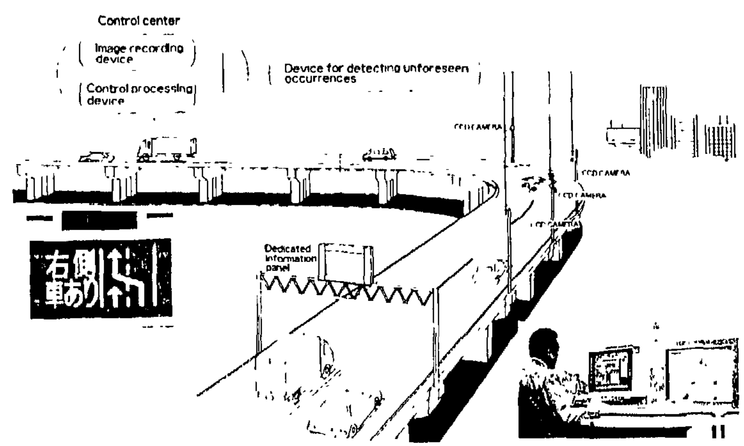
ITS
Intelligent Transport Systems

Considerations regarding AHS

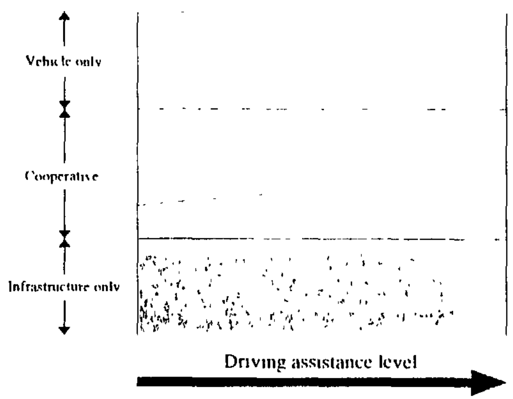
Panel of Transportation Operators

Incidental Detection System

Illustration of the system installed at the Awaza curve



Spectrum of AHS

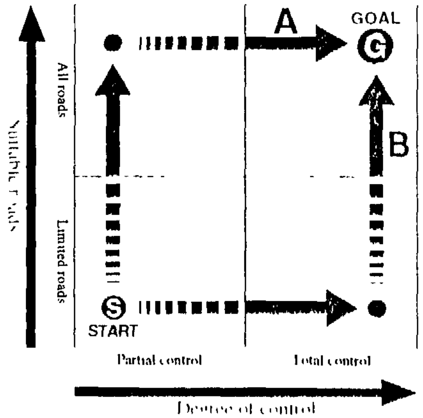


Points for discussion regarding AHS

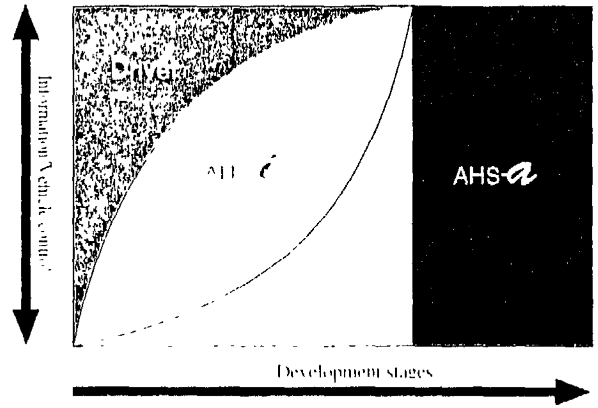
1. **Evolutional process**
2. **AHS-i,AHS-c,AHS-a**
3. **AHS-i and AHS-c make progress in parallel**

Attachment #12-2-C

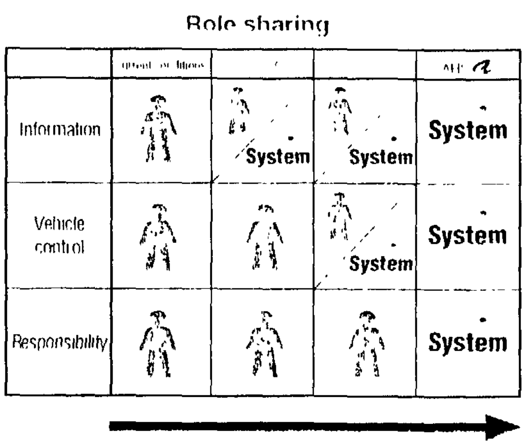
Two Processes to achieve fully automated driving



AHS Evolution



Subsystems of AHS



The number of the dead by accident on road in Japan 1995

			Car drivers				motorcyclists	cyclist	pedestrian	Others*	TOTAL
Vehicle to Pedestrian	Crossing	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Along carriageway etc		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Vehicle to vehicle	Head-on collision	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Side contact while passing by		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Rear end collision	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Right angle collision		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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Vehicle to only	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Vehicle to train		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Sub total		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	TOTAL		[illegible]				[illegible]			[illegible]	[illegible]

[illegible]

Analysis of accidents that occurred in Japan

ITS

Number of persons killed [illegible]	10,679
Number of those who were [illegible]	4,299 (40%)
--> AHS-i will be effective	
Number of those [illegible] in [illegible] operations	3,705 (35%)
--> AHS-c will be effective	

Setting of the research goal and international cooperation

ITS

Setting the target year for development will be effective

International cooperation is indispensable

- Operational compatibility
- Efficient technological development
- Reduced cost

Points for discussion regarding AHS (Addition)

ITS

4. Safety is the primary objective of AHS in the short term

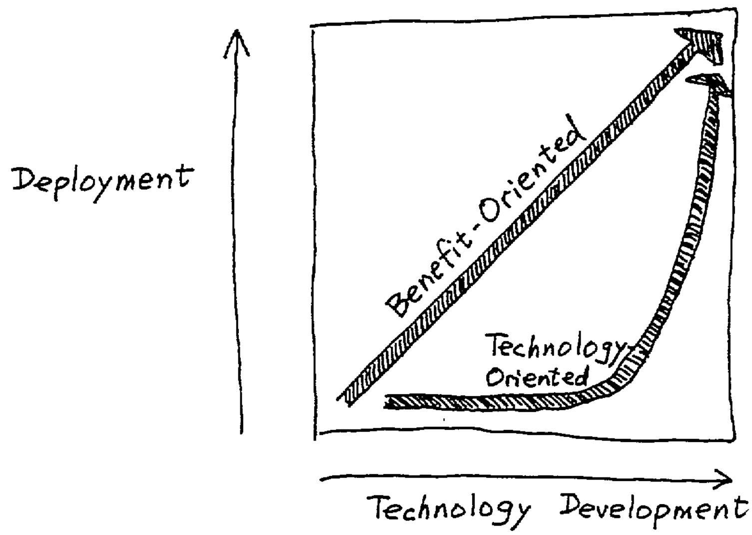
5. The dedicated lane is considered as an option

6. The distribution of intelligent functions to a vehicle and infrastructure should be optimized

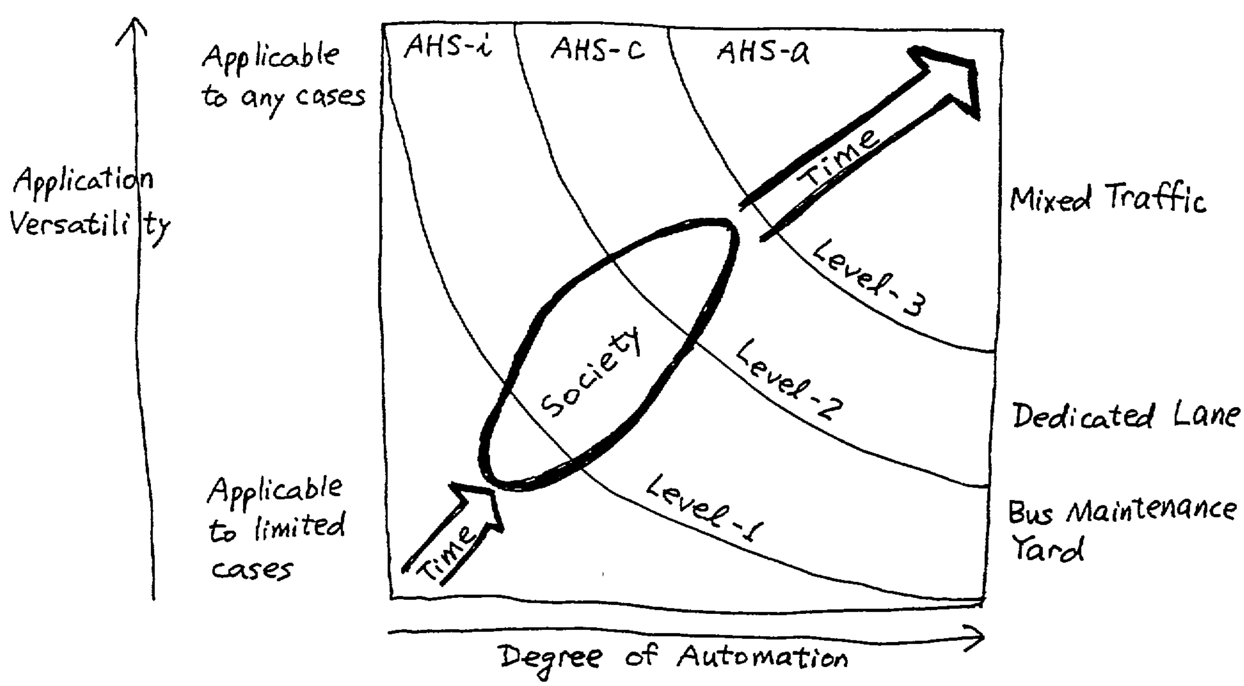
Ichiro Masaki, MIT
masaki@mit.edu, phone (+1) 617-253-8532

Approaches for ITS

(1) A benefit-oriented approach (or an evolutionary approach) is better than a technology-oriented approach (or a revolutionary approach).



(2) Two-Dimensional Benefit-Oriented Approach



HOT ISSUES

Attachment #12-3-B

Infrastructure as an enabler -12
- sensor friendly
- designated lane

Deployment Paths -27 3
"A" OEMs
"B" aftermarket + private roads PLATFORM

User Services Definition -6

What are the DOT benefits? 30 2

User Acceptance / Public Perception 24 4

Regional Deployment - Commonality / Tailoring ? 9

Define Functional Standards Needs ✓ 18 7

Assess Benefits & Effectiveness ✓ ✓

MMI Integration 17 8

System Integration Ø

Public Education ✓

Common Understanding of "AHS": definition, stages 32 1

Product Liability 13

MORE HOT ISSUES

ESTABLISH + Understand VISION 11

PROVIDE LEADERSHIP 4

Commercial Vehicle Applications 15 9

Planning / Coordination Future Activities / Other Activities

GOVERNMENT INCENTIVES/FACILITATION for Products

Human-like Driving - Possible? 10

Global Time line

[illegible] 13

[illegible] 20 5

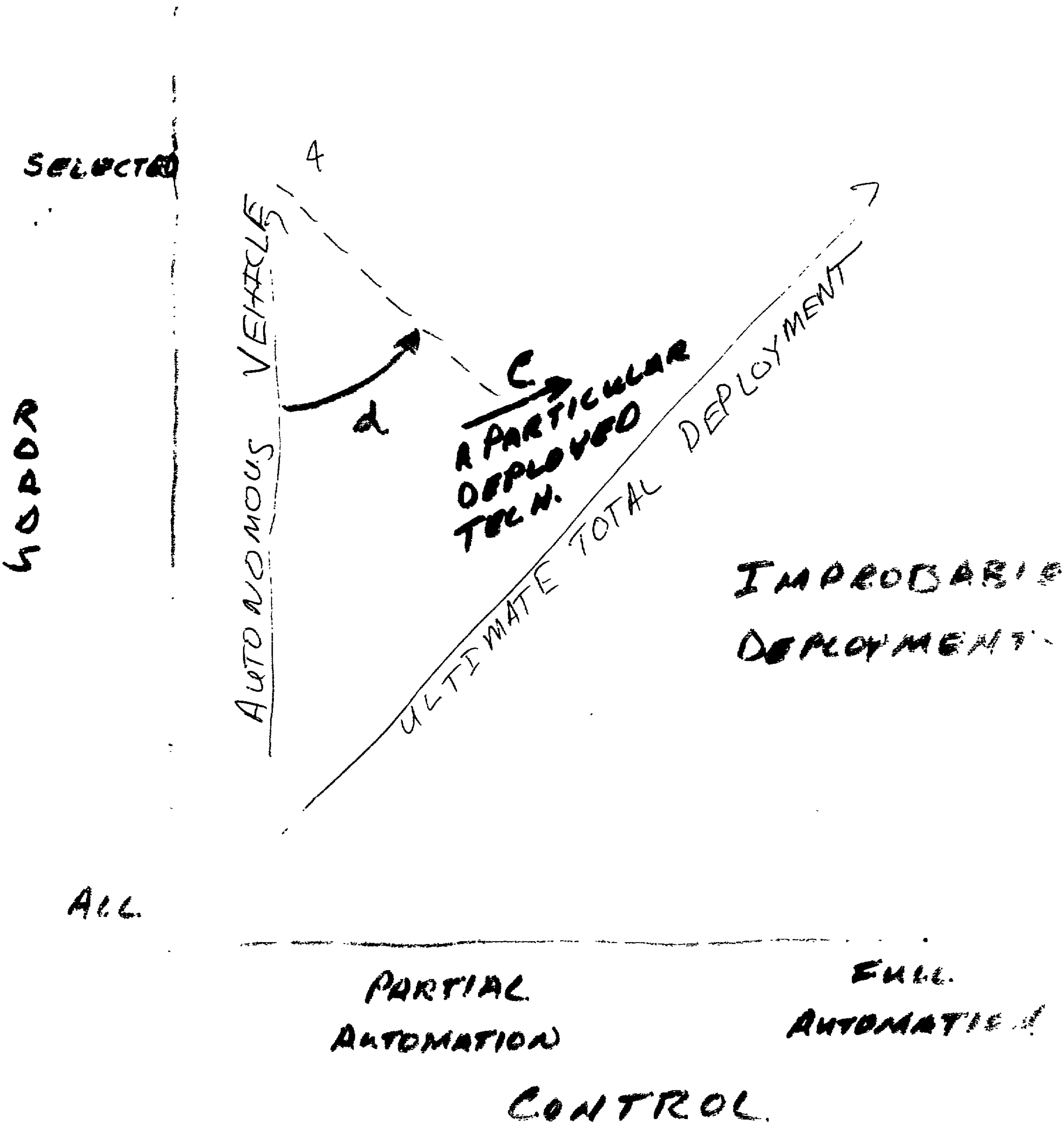
[illegible]

Defining the Public-Private Partnership (+ int'l) 10

"List" Subsystem Functions Available (Techno) 19 6

System Integrity / Fallback Modes 14 10

Transit 6



$\alpha = f$ (MARKET FORCES & VEHICLE PLATFORM)

$AC = f$ (TIME & FUNDING TO DEV. & DEPLOY)